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Chinese Market Gardening in Singapore: a Study in Functional Microgeography.

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CHINESE MARKET GARDENING IN SINGAPORE:
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TABLE OF CONTENTS

CHAPTER PAGE

LIST OF FIGURES

LIST OF ILLUSTRATIONS

LIST OF MAPS

ABSTRACT

Cantonese farmers in portions of Singapore Island practice a highly intensive form of commercialized vegetable farming. The present dissertation reports on an investigation of this farming system. The aims of the investigation were twofold: to analyze the functional and historical processes characterizing this farming system; and to test in the field a conceptual theory, termed here _process analysis_, designed for studies in cultural geography focussing on resource-using processes rather than areal differentiation.

Process analysis consists of an interlocking system of concepts covering all aspects of any resource-using situation, and thus provides a theoretical framework for the analysis of culture-environment relations. Resource-using situations are shown to consist of _material_, _behavioral_, and _orientational_ (or motivational) processes, orientation, in turn, being made up of resource apperception, technical skill, and values. Such situations group themselves into persistent and localized complexes (e.g., a farm; a factory), or resource-using _fields_. The fields are viewed either in terms of the short-run interaction of their component processes, in which case they may be called _functional_ fields, or in terms of their long-run evolution, in which case they may be called _historical-process_ fields. _Functional analysis_ and _historical-process_

analysis correspond to each of these viewpoints, respectively.

Process analysis, by investigating all aspects of a resource-using situation, bypasses environmentalism, the result of lack of attention to such key elements as orientation. It thus removes the principal objection to a definition of the goal of cultural geography as the study of culture-environment relations. The more commonly accepted goal, the study of areal differentiation, is shown to be a special case of the former, one which partially excludes studies (such as the one described here) of functional and historical process.

Making use of the conceptual system summarized above, the investigation dealt with the following topics relevant to Cantonese leaf-stem vegetable farming in Singapore: the contemporary setting, cultural and physical; prior evolution; component functional processes; and a synthesis, or functional model, of the vegetable-farming field.

High demand, by Singapore's Chinese population, for Chinese vegetables, and distance of most competing farms from Singapore markets, are important factors in the cultural setting favoring the island's leaf-stem vegetable farms. The physical setting includes an equatorial climate and poorly drained alluvial, clay soils. The vegetable-farming field is shown to have migrated without essential change from South China to its present location. By contrast, the slopeland mixed farms of the island, producing pigs and crops other than leaf-stem vegetables, have evolved from pepper and gambir cultivation in 19th-century Malaysia.

The Lower Kallang Plain, the most important leaf-stem vegetable farming area, was focussed on in this study. The area, largely within the city of Singapore, includes 170 farms, averaging one-half acre in size. The modal dwelling unit consists of seven people, and rural population density is about 8,000 per square mile. The only crops of significance in the plain are some eight varieties of leaf-stem vegetables. The average yield is fifty-eight tons per cultivated acre. Thus, in terms of size of farm, population density, and yield rate, farming in the plain is highly intensive.

This intensity can be explained functionally in terms of the following factors, among others: Labor input amounts to seventeen man-years per acre per year; organic fertilizer (prawn dust) is applied at the rate of fifty-two tons per acre; and hand-watering adds perhaps fifty inches to the annual rainfall of ninety-five inches, while careful tillage and organic fertilizing simultaneously maintain soil aeration.

It is concluded that process analysis not only proved usable in the study, but opened up many fruitful avenues of investigation.

INTRODUCTION

BACKGROUND AND HISTORY OF THE PROJECT

Origins of the Research.--The field work on which this study is based was undertaken in Singapore between December, 1951, and June, 1953. The project was first conceived as a modest investigation of a few farms, its purpose being simply to test certain theoretical ideas and obtain a qualitative picture of the microgeography of Singapore agriculture. Shortly after its inception, however, the project received the first of a series of grants from the Singapore Government, which had become interested in the possibility of extending the research to a point where quantitative generalizations might be obtained. Thus the work gradually expanded from a small study involving one investigator and an interpreter to a major field program, employing, during its major phases, between twenty and thirty University of Malaya geography students as field investigators, and requiring the assistance of government personnel and equipment in field transportation and statistical office work.

The project began shortly after the writer's arrival in Singapore in November, 1951, where he was to take up a two-year appointment as Assistant Lecturer in Geography at the University of Malaya. Research plans for this period involved the general aim of selecting one of Malaysia's more significant farming systems and analyzing it from the standpoint of process-oriented cultural geography, by means of the micro-geographic method. A specific field-work site had not been chosen, and no thought had been given to working in the notably urbanized Colony of Singapore itself.

However, it soon became evident that this colony possessed some of the most interesting farming systems in the region. Within sight of the writer's house were several small, commercialized, intensively worked Chinese farms, and an inquiry made of the Agricultural Department brought out the fact that several thousand farms of this general type were scattered about the island. Yields and labor intensity were known to be high, and farms were believed to average between two and three acres each, though exact figures were unavailable. In company with Mr. P. G. Tan, the Agricultural Assistant responsible for extension work, the writer spent several days observing the farms. As a result of these tours, a small research program dealing with them was decided upon, one which would take place during the University of Malaya's academic year and thus would not interfere with any major research during the long vacation of 1952.

In December, 1951, the writer was introduced to Mr. R. A. Wright, Chief Veterinary Officer, the individual charged with the responsibility for developing a program to increase domestic supplies of perishable vegetables and meat. Mr. Wright suggested that the research frame would provide much of the background data needed by the government for its food production planning, if the scope of the work could be expanded to cover a significant number of farms. He offered the financial assistance of the government in hiring qualified university students as field assistants, on a university-government cooperative arrangement which had proved successful in the past for other research projects. Having by this time become quite interested in Singapore's agriculture and in the possibilities for developing a research program which would contribute to local agricultural planning, the writer gladly accepted.

Phases of the Research.--Phase One of the study consisted simply of a pilot microgeographic study in one of the more important farming areas of Singapore, Jalan Tiga Ratus, an upland sandy-loam area near the eastern end of the island, producing pigs, fruit-and-earth vegetables, and some minor products. The purpose of this phase was to train field workers, refine the interview schedule, and develop suitable mapping and observation techniques. With the kind assistance of Professor E. H. G. Dobby of the University's Geography Department, arrangements were made to employ student volunteers from this department. Field work began in March, 1952, the study by this time having been given the title of the "Singapore Rural Economy Survey" (later shortened to the "Singapore Agricultural Survey"). Ten students participated during a twelve-day field period. (See Chapters V, VI, and VII for a detailed description of each phase of the field work.)

Phase Two, the major field effort, was to take place during the "summer" vacation. The intervening months were spent in preparation for this work. Two problems occupied the greatest measure of time during this period. The first, and most important, was that of selecting areas for study. Dr. Peter You Poh Seng, Lecturer in Economic Statistics at the University, and the writer made strenuous efforts to devise a sampling scheme which would provide a random sample of the island's farms, but, for reasons explained in Chapter V and resting ultimately on the lack of preliminary data, the effort had to be abandoned. (One means of obtaining the data for sample selection would have been an initial cursory farm census of the island, undertaken at the outset of the work to enumerate and locate the island's farms. But the government was unwilling to make long-term financial commitments, and it was feared that such a farm census might leave insufficient funds for the subsequent intensive study.) The criterion finally adopted for selection of study areas was that of agricultural significance: the four most highly concentrated and significant areas on the island were singled out for field study. (The reasoning behind this approach is explained in Chapter V.) The writer made a number of trips around the island selecting the areas for field work.

The second problem involved the gathering of materials needed for the field work of Phase Two. Prints of aerial photographs covering the island, and flown some two to three years before, were available, and photostats were obtained for the areas selected. Topographic maps on the scale of 1:25,000 were also obtained, but these were based on pre-World War II surveys, and had lost much of their value as a result of changes taking place during the Japanese occupation. Other materials, such as a chain, paper, pencils, and sufficient quantities of the questionnaire, were also assembled.

Phase Two began in June, 1952, and continued through early August. Investigation of the area studied during Phase One was completed; one other area (the Lower and Middle Kallang Plain) was covered thoroughly; and groups of farms in two other general areas (Lokyang and Yio Chu Kang) were studied. A total of about 375 farms was investigated, this figure representing very roughly an eight per cent "sample" of the island's farms. Thirty students participated during the nine-week field period.

During the final months of 1952, the government agreed to appropriate a supplementary sum for the cursory farm census referred to above, to be undertaken during the Christmas vacation of 1952-53. However, it proved impossible to finish the project, Phase Three of the research, during the twenty field days of this vacation, although twenty-two students participated, and ten government landrovers and their drivers were put at our disposal. Sufficient funds were left over to do some additional work (with four students) during June, 1953, but the supplementary appropriation which would have permitted completing the census was not forthcoming prior to the writer's departure from Singapore on July 7th. In total, the census covered about 70 per cent of the farms of Singapore. Some extension of the data proved possible through the analysis of air photos, however, and the census provided useful information both for extrapolation from the intensive data previously obtained, and for estimating the number and location of farms of each type throughout the island. Data from the census were put on punch cards, and a printed tabulation of these cards was obtained. Full statistical analysis of the punch card data from the reconnaissance census must await programming by the Office of the Registrar of Malayan Statistics.

Phase Four consisted of a highly intensive study of one farm, that of Ng Hong, in the Lower Kallang Plain. This phase of the work began during the planning stages of Phase Three -- while air-photo analysis for subsequent Phase Three field work was taking place -- and lasted from November, 1952, to March, 1953. This phase of the work resulted in a publication on the Ng Hong farm itself (Blaut 1953).

In the present dissertation only a portion of the data obtained during the project described above has actually been incorporated: The study as a whole proved to be too large and diffuse to form the subject of a dissertation. Data on leaf-stem vegetable farming have been extracted from the study as a whole. However, the lack of punch-card tabulation has restricted even this aspect largely to the intensive information obtained during part of Phase Two -- the data from the Lower and Middle Kallang Plain, and part of the Lokyang data--and the data obtained on Ng Hong's farm (Phase Four).

PART I: AIMS, THEORY, METHODS

CHAPTER I

RESEARCH GOALS

Substantive Aims.--The primary goal of the research on which this dissertation is based was to describe and interpret the farming processes found on Singapore island, with a view toward accomplishing four substantive objectives. The first of these was to obtain background information needed for agricultural development planning in Singapore. The second was to add to our meagre, though slowly accumulating, store of knowledge about the cultural geography of tropical smallholder agriculture in general. The third objective was to add also to our knowledge of the variety of Chinese farming types and processes in different cultural and environmental settings. And the fourth was to determine the significant historical and short-term processes which help explain the extraordinary complexity and intensity of Singapore's farming systems. A second group of aims was theoretical and methodological. What is termed here the "functional" orientation was to be tested in this field setting, to determine its usefulness in obtaining descriptive and explanatory understandings. Microgeography was to be employed to determine whether it would contribute to intensity and exactness of results in this context. And a multidisciplinary approach, centering on cultural geography but drawing heavily on the methods and viewpoints of agricultural economics (particularly farm management), crop ecology, soil science, and economic anthropology, was to be given a field trial, to determine whether integration of these disciplines would prove feasible and useful in the study.

The first of the substantive aims, that of contributing background data for agricultural development planning, can best be understood in terms of the manner in which the project originated, as explained in the foregoing Introduction. The work was not considered to be one in "applied" geography, except peripherally, either by the investigator or the Singapore Government. The latter felt that the "pure" aims of the work would lead to the gathering of basic data for development planning. The data sought were, in general, those needed to build up a picture of processes of production and related aspects of the farms, and to determine the manner in which external, impinging, processes affected them. The study not only obtained factual material on topics relevant to planning--yields, income, costs, crop and livestock types, farming population, and the like--but also provided a means of qualitatively predicting the probable results of certain proposed policies. Such prediction is an implicate of "processual" cultural geography, involving simply a projection forward in time of the processes found to be operating during and prior to the research "present." (This point is explained in greater detail in Chapter III.)

However, two requirements were imposed on the study by the aim being discussed here. One was the necessity of providing data which were as representative as possible, preferably of all farms in the island, but at least of a significant portion of the total. The ideal goal was perfect statistical representativeness with as little sampling error as possible, but it proved impossible to attain this (see Chapter V below), and an approach allowing only limited representativeness had to be substituted. Partial representativeness was attained by investigating a large number of farms, 375 in all, in carefully selected areas. A second requirement was detail and accuracy, sufficient to provide more than vague estimates for planning. Considerable detail and accuracy were also required for other purposes, as, for example, to provide a means of gauging the intensity of certain processes and their degree of effect on others. But the planning requirement established a minimum level, which added perhaps one-half to the field work time devoted to each farm, and correspondingly reduced quite sharply the possibilities of exploring other subjects not related to planning needs. In addition, the data emphasized in order to satisfy "applied" aims of the work were those normally considered by agricultural economists rather than geographers, and a strong shift of emphasis thus took place, the field work itself taking on some of the character of a combined study in geography, farm management, and related fields, rather than an economically oriented study in cultural geography.

The "applied" aims of the project can, perhaps, best be illustrated by quoting from the first report of the Singapore Agricultural Survey:

> Specifically, the Survey sought to provide partial answers to the following questions, among others: (1) How can Singapore's food production be further intensified on existing farms? (2) How can production and marketing costs be reduced in an effort to reduce urban food prices and increase farm income? (3) What would be the reactions, in terms of production and farm levels of living, to both planned and unplanned changes in impinging economic forces and environmental -- notably drainage and water supply -- circumstances? (4) What natural land classes are most suited to the types of farming practised in Singapore, and, therefore, what classes of land might prove most suitable for expanding farm area? (5) What agricultural criteria should be taken into account in zoning food production reserves in the face of a widening urban margin? (Blaut 1954c:2.)

The "partial" nature of the answers being sought reflected the fact that background data rather than policies were dealt with, and the fact that lack of representativeness limited the generality of results.

A second group of substantive aims dealt with the possible uses elsewhere in the tropics of the material collected in Singapore. While farming in this island is quite atypical of Southeast Asia and the tropics as a whole, an understanding of the Singapore pattern should prove of value in developing an understanding of small-holder patterns in these broader areas.

Gourou (1953:79-80) mentions a smallholder system in Martinique which may obtain higher yields than those obtained by the Chinese in Singapore, but, apart from this possible exception, the Singapore leaf-stem vegetable system is the most intensive, in terms of yields per acre, of any farming system in the tropics of which the writer has learned. (Its yield may, in fact, surpass maxima obtained under field conditions in temperate areas, if we exclude from consideration such partly artificial systems as hydroponics and greenhouse cultivation.) Thus the present study serves as a means of estimating realizable maxima in yields under tropical conditions, and analysis of the Singapore system should not only provide an example of farming at or near one end of the scale of intensity, but should also provide material for comparative studies which seek to determine the reasons why other systems fall short of the maximum. One of the key aims of the study described here, therefore, was to determine the intensity of production in Singapore's leaf-stem vegetable system, and to inquire how this intensity had been achieved--in terms of technological background, local economic and environmental conditions, and value-orientations.

A related aim was to build an understanding of the leaf-stem vegetable farming system <u>as</u> a resource-using system, an integrated set of behavioral, material, and valuative processes. (See Chapter III for a discussion of these theoretical concepts.) Such an understanding involves generalizing the relationships found among these process elements on each farm to the system as a whole. Each such relationship, and each process element, presumably has its analogue elsewhere, and if we can determine the effect of, say, a readily accessible urban vegetable market on any one internal farming process in Singapore we can then seek the same relationship elsewhere and perhaps come up with some pan-tropical generalizations.

Each of the foregoing implies prior knowledge of the basic mechanics of this farming system--detailed, factual data on all relevant phases of behavior, materials, and (to a somewhat lesser extent) values. Thus we can consider the primary aim of the work to have been to collect such data at the highest level of detail and exactitude possible. It will be noted that most of this dissertation is devoted to presenting such factual material. This merely mirrors the necessity of providing fundamental facts which can then serve as the basis for realizing other aims, "applied" and "pure." If none of the derivative aims of this work had been realized, it would still add to our meagre store of exact data on tropical smallholder cultivation.

But factual understanding of this sort does not consist merely of static description, statistics on yields and labor, maps of the distribution of farms and farming elements, or accounts of farming patterns. Unfortunately, such information was unavailable and had to be gathered in the field during the course of study, but the actual goal was wider in scope. Static data of the above sort do not lead to explanatory understanding or to prediction. The problem thus became one of attaining time-depth, in order to achieve an understanding of patterns as functional processes, and to project these patterns backward in time to their middle-run origins. Only in this way could the dynamics of the system, "causes" in the general sense, be treated. In Chapter III our use of the terms "functional" and "historical" will be explained; here we need merely state that the most fundamental goal of the work was the attaining of functional and historical understanding of the leaf-stem vegetable system in Singapore as a basis for further generalization.

Theoretical Aims.--From one point of view this study can be thought of as an effort to understand Singapore agriculture as such, while from another it can be thought of as an experiment with several theoretical ideas, the farms being used merely as a kind of field laboratory in which they could be tested. Some of the ideas antedate the field work itself: The writer came to Singapore with the intention of testing them in whatever field setting presented itself. But during the course of the study they became altered and in some cases considerably expanded, so that many of the theoretical results of the work bear little resemblance to the initial aims. However, a very general statement of these prior aims should serve as a basis for judging the extent to which they proved useful.

Cultural geography, in the larger sense of "human geography," has exhibited a strong preference for static, space-oriented research over the more dynamic approach stressing process. Before coming to Singapore, the writer came to the conclusion that a more analytical science of cultural geography, one which sought causes and explanations, could be obtained only by laying greater stress on process and correspondingly less on space. (This argument is carried forward in Chapter II.) However, most precedents for process-oriented research seemed to fall back into environmentalism, by stressing supposed functional relationships between man and environment without considering the intervening variable, culture, which renders such direct relationships invalid. It seemed desirable, therefore, to attempt a field study which would be strongly process-oriented, yet devoid of environmentalism. The field work itself would deal with short-run processes, of the sort termed here "functional," subsequent analysis of historical materials tracing the contemporary processes back to their long- or middle-run origins. This aim required that the research frame be designed so as to stress dynamic phases of Singapore farming, with distributional analysis limited to the role of determining the areal expression of the farming processes.

Two general problems in methodology, as contrasted with theory proper, had also been formulated before the present study was begun. A convergence had been noted between the needs of process-oriented research and those of research aiming to contribute to socio-economic development planning. This involved the problems of detail and breadth. In both cases highly detailed data had proven themselves necessary, to the former because process data are notably elusive, and to the latter because a high threshold of quantitative exactness must be established in order to ensure the success of subsequent development programs. And both areas of research required exceptionally broad data, extending far beyond the conventional boundaries of cultural geography in a number of directions. Process analysis requires the investigation of behavior and values, neither considered in any detail in conventional treatments of an area, and more detailed analysis of such elements as crop ecology and farm management than one normally finds in geographic study. Planning research requires the same, since plans must be built on data ranging from those of sociology to those of climatology. Thus the present study had, among its initial aims, two which can be considered methodological, since they involved testing methods which would prove applicable to other studies in process-oriented cultural geography and in planning geography. These were: (1) to develop a method for handling data at the highest level of detail attainable in a study covering a reasonably large piece of ground; and (2) to develop a method for a combined, multidisciplinary, attack on problems of agricultural geography, integrating the methods and viewpoints of cultural geography and a number of bordering sciences, such as farm management, crop ecology, and soils. The actual methods developed will be discussed in Chapter V through VII below.

Scope of the Dissertation.--The scope of the research was considerably too broad and too diffuse to permit a monograph of the present sort to be written about the work as a whole. Accordingly, we have elected to deal here with two aspects of the research. A full discussion of theory, and thus of the theoretical aims mentioned above, will be presented. As to substantive data, we shall be dealing with the leaf-stem vegetable farming system alone, discussing the upland mixed-farming system only briefly, in Chapter X, which concerns historical geography and also defines the farming systems of Singapore. Even within the leaf-stem vegetable farming system, many of the island-wide data will be ignored, and the discussion will center on the Lower Kallang Plain which, although it includes nearly half of the farms of this type in the island, does not reveal all variations which exist in the system.

In spite of the necessary abbreviation of the work, all of the aims, theoretical and substantive, apply to the present dissertation. What we have done has been to extract one unified body of data, that concerning Lower Kallang Plain leaf-stem vegetable farming, and discuss it from all points of view described in this chapter.

CHAPTER II

THEORY: CONCEPTUAL UNDERPINNINGS

Rationale.--Geographers traditionally have been content to report their work in a straightforward, factual manner, encumbering their writing with few if any theoretical observations. The present paper departs from this tradition for two reasons. First, while geographers tend usually to assume, rightly or wrongly, that the underlying conceptual framework for their work is known to, and shared by, their readers, such an assumption cannot be made here: The present study employs a conceptual system which, though its basic elements are by no means new, departs considerably from current formulations. And second, theoretical questions were central to the work itself: Among the principal aims of the study were the goals of testing in the field certain aspects of cultural-geographic theory whose inadequacies had been suspected, of attempting to formulate alternatives for those aspects found to be inadequate, and of testing these alternatives.

From the standpoint of theory, this dissertation can be viewed in large part as an attempt to answer two basic and related questions. First, is it possible to have valid research concerned directly with the processes involved in resource use -- i. e., in man-environment relations -- yet devoid of environmentalism? And second, would such a study fall within the realm of cultural geography? In order to answer the first question, it proved necessary to formulate a set of basic concepts oriented toward process, and, from them, to establish categories of data which the substantive work would then employ. The second question appears on the surface to be merely one of the "but is it geography" variety; however, in this context it has wider implications. Current definitions of the field, most of which are oriented, as we shall see, toward "space," "areal differentiation," and the like, rather than toward man-environment relations, appear to exclude studies of the present sort. It is germane to inquire whether a broader definition of the field can be formulated, one which, while avoiding environmentalism, encompasses both "relational" and "spatial" viewpoints. Past writers on the methodology of geography have tacitly assumed that a synthesis of these two viewpoints is unattainable.

<u>Concepts of Space, Time, Process, and Relationship.</u>--Our concern in the following paragraphs is with several assumptions and concepts which are basic to geographic theory. The problem to be considered is whether they serve adequately for studies of the present sort.

The most fundamental notion in current geographic theory is the concept of <u>space</u>. "Space," according to Whittlesey, is "the basic organizing concept of the geographer" (1954:28). Finch, Trewartha, <u>et</u>. <u>al</u>., inform readers of their text that "location, distribution, arrangement, and association are concepts which...are at the heart of geographic study" (1957:viii).

According to James, "those who face problems involving the factor of location, or involving the examination of conditions peculiar to specific locations, are concerned with geography, just as those who must be informed about a sequence of events in the past are concerned with history" (1954:4). Thus "space," "area," " location," "distribution," "arrangement," and the like are conceived by many to be a central conceptual foundation for the field of geography as a whole, and to provide a valid basis for a definition of geography (and cultural geography) in spatial terms.

Let us first make the assumption, commonly held by philosophers of science, that macroscopic, presentational reality consists of an indissoluble fusion of space and time, of "space-time." (Cf. Russell 1927:49.) This view states that the concepts of "space" and "time" are merely abstractions from a single spatio-temporal reality; that we cannot treat time as having any empirical reference apart from changes in observed, extensional things, nor consider space to exist in a static, non-changing, timeless fashion. We can, in fact, have no direct experience of timeless space or of non-extensional time. It is important to note that this view, deriving in part from relativistic physics, in part from non-Euclidean geometry, and in part from the philosophical reaction to Kantian and idealistic thought, is accepted by nearly all philosophers of science today.

The term <u>process</u> is generally used for this spatio-temporal flux from which the two abstractions "space" and "time" are drawn. Reality, we assume, is processual.

Although the raw data of science are processual, it is useful for certain purposes to abstract the spatial or temporal property; in doing so, however, we must be careful not to reify the abstraction, and speak of "spatial phenomena" or "temporal phenomena" which, as we have argued, do not exist. The term structure can be employed to designate such abstractions. In the present discussion we shall be using the term to indicate the spatial rather than the temporal dimension.

Two sorts of abstraction can usefully be distinguished. The sort implied in the term "spatial structure" (or in such terms as "color," "form," "hour") refers to a property of phenomena. The second variety refers to a grouping of phenomena, a classification of units or segments. "Man," "price," "air-mass," and "mountain" are examples of this latter. This distinction is introduced here to permit a general statement about all sciences, or organized subject-matter fields: No science is defined in terms of a high-order abstraction of the first (property) sort, for the simple reason that a field so defined would possess no subject matter, merely a property. Mathematics and fields of logic are defined in this manner, but they do not deal with real phenomena, rather with rules and logical forms, and thus are not sciences in the sense used here.

It seems clear, therefore, that geography cannot be defined as a "science of space," or of "space relations" (relations of proximity, not connectedness), or of distribution. However, can "space" survive as "the organizing concept of the geographer?" For it to do so, two conditions would have to be fulfilled: (1) We should have to define the subject matter of the field in processual terms; and (2) we should have to demonstrate that there is some value in organizing our subject matter in terms of space relations, relations of proximity, and thus in terms of simultaneity.

According to Hartshorne (1939), geography studies the association of phenomena in terms of place (184), the "areal differentiation of the world" (468). Implicit in this chorological view, which is similar to that of Hettner, is an acceptance of the idea of space as a central organizing concept. The chorological approach can therefore be termed "structural," since it focusses on the space-abstraction, although Hartshorne does not commit the error of imagining the subject matter of the field to be abstract space as such. Hartshorne, following Hettner, establishes three criteria for inclusion of phenomena in geography (240-247): (1) They must be causally connected to other kinds of features of the earth's surface; in the case of cultural phenomena, they must be somewhat related to the physical environment. (2) They must differ from place to place, i.e., must be areally differentiated. (3) They must have significant "areal expression," which generally means that they should cover significant segments of the earth's surface or, if they are not material (and therefore without such concrete expression), should be translatable into areal units -- e.g., into areas of similarity in a non-material feature, into a mapped ratio.

This definition of subject matter fits the first of our conditions: The phenomena referred to are processes. It does not fit the second; in fact, the notion of space relations and simultaneity can be eliminated from it without affecting the kinds of phenomena dealt with or the methods employed by the geographer in dealing with them.

The first of Hartshorne's criteria, taken alone, would yield as subject matter for geography a kind of general ecology -- the synecology of nature, man included, and (in its systematic or topical phases) the autecology of the different realms of nature, that of man being cultural or human geography and being definable as the study of man's relationship to his environment. That Hartshorne does not conceive the field to be this is clear: "to insist that...phenomena... must be causally interrelated with other regional phenomena is not to define geography as the study of relationships" (243).

The second criterion does not significantly narrow the field, since most of the important elements found in any area are, in fact, irregularly distributed over the earth's surface. One who holds the view that the first criterion is sufficient can point out that the few important elements which are more or less evenly distributed over the earth's surface (e.g., air, for non-urban, non-mountainous places) are merely treated as constants rather than excluded from consideration.

The third criterion can be reworded without, it appears, changing the meaning, to state that phenomena which occur only rarely are of less interest than those that occur frequently -- are found in many places, or throughout much of a given area. Stated thus, the criterion becomes obvious, and neither narrows the subject matter of the field nor modifies the first criterion, which describes geography as the synecology and autecology of the earth's surface.

There is, however, an unstated criterion which does modify the first, and requires the notion of simultaneity. This is implied in a quotation from Hettner given by Hartshorne (184): "geography...lays a limited cross-section through a particular point of time and draws on temporal development only to explain the situation in the time chosen." The reference to a "point of time" is inexact: Situations at the very least extend over short periods, having recognizable temporal duration, if we accept the processual view. Nor is it correct to say that "the majority of the facts that the geographer can directly observe are by nature static; the processes studied...must be deduced hypothetically from the static facts -- or taken down from historical records" (178). These objections aside, what we have is a limitation of geographic study to situations prevailing over short periods of time, cross-sections (rather, slices) through time. Geographers may extend their scope of attention as widely as they choose, spatially, but must limit their attention temporally, delving into prior development only to explain the short-term situation.

Would this criterion prevent the geographer from comparing the eruption of Krakatau with more recent eruptions elsewhere?

From contrasting the American frontier at two successive times and places? From establishing a classification of cities which includes some types no longer in existence? The answer would appear to be yes, in all these cases, since the criterion limits the focus of a given study to a particular time. It is not surprising, then, to find Hartshorne criticizing Sauer's genetic viewpoint, which will be discussed below.

Without the notion of simultaneity, the idea that the geographer's subject matter tends to fall into narrow segments of time, Hartshorne's definition of subject matter appears not to differ from a processual view which is not constricted temporally, one which deals with "the synopsis of the earth's surface and the life belonging to it, as a whole, unified by manifold correlations" (Ratzel 1882:17), or with "the surficial connections of the three states of matter, and the actions and reciprocal reactions of the terrestrial milieu and the world of life" (Vallaux 1929:405) -- in a word, with the synecology and autecology of phenomena on the earth's surface. If, however, the emphasis on space, or simultaneity, is retained in the definition of subject matter, the resulting view of geography leads us into difficulties. The difficulties become serious in regard to systematic geography in general, and cultural geography in particular.

One problem stems from the irreconcilability of the criterion of causal interrelatedness and that of simultaneity. Many features found together in the same region at the same time are not interrelated, except remotely and unimportantly, with one another. Since these features do not serve as causal elements for each other, a study of the region will tend to be descriptive rather than explanatory unless full historical-process analysis is undertaken -- and, as we shall see, the latter is not stressed in the chorological viewpoint. Stated differently, explanatory analysis can proceed in two ways, either in terms of current processes of interaction among elements or in terms of long-term historical change. The former is apparently excluded, since "geography studies the integration of phenomena in areas under the assumption of fixed time" (Hartshorne, op. cit., 184), and "the majority of...facts...are by nature static" (178), but in any case cannot work satisfactorily for non-integrated phenomena. The latter requires exhaustive historical-process analysis, but "any consideration of time relations must be secondary and merely supplementary" (176), so that explanation is secondary and merely supplementary to description in regional study: "regional geography...is essentially a descriptive science" (449).

Thus, the chorological or areal-differentiation view tends to separate the space-oriented treatment of compresent phenomena from the treatment of their historical antecedents. Historical aspects are frequently relegated to the role of a non-explanatory, sequential introduction to the contemporary scene.

A second difficulty has to do with the tendency of the chorological viewpoint to treat historical geography as the study of cross-sections through time rather than extended periods Study of the evolution or changes in a region through a significant period of time, a field intensively and fruitfully cultivated by Sauer and his students, is thereby excluded.

A third difficulty is the tendency to disregard the detailed treatment of localized phenomena, the field of "micro-geography," in favor of broad areal studies. The former gains importance largely from the fact that significant processes can rarely be discovered in any other way than by detailed local study, either "micro-regional" or "micro-systematic" -- broader areal coverage for a narrow range of phenomena. When emphasis is shifted to areal differentiation rather than process ("the interest of the geographer is not in...origins and processes" -- Hartshorne, op. cit., 425), an area or feature becomes significant in part through spatial extent. The present study, for example, deals largely with a thoroughly insignificant area of about one-half square mile, but the processes at work in the Lower Kallang Plain are of interest qua process.

With regard to systematic geography, both Hartshorne and, more recently, Ackerman (1945) define its field of attention as, generally, the comparison or correlation of distributions. A single element is not of interest in itself, but only in (1) its distribution, (2) the relation of its distribution to other distributions, and (3) the explanation of its distribution. (Hartshorne allows only the second of the three, excluding the analysis of genesis, process, and distribution *per se* from systematic geography.) We may assume that the elements dealt with are such as would be agreed to by ecological-minded geographers as well as chorologists.

Distribution is a property of all classes of phenomena, and as such is to be studied by the field concerned with that class of phenomenon. (Cf. Hartshorne, *op. cit.*, 127-129 and 415.) The explanation of the distribution cannot be divorced from any explanatory analysis of that class of phenomena, and thus, also, would appear to belong elsewhere than in geography. This leaves systematic geography only the comparison of distributions. But to compare distributions in an explanatory fashion one must examine the effect of one class of phenomena on the other. To do this scientifically one must also understand the effects of *other* classes of phenomena on the first, and this, as we have seen, leads us out of chorologically defined geography. Thus systematic geography, according to this view, can do little beside correlating distributions, and this is a descriptive, rather than explanatory, effort.

The divergence between an ecologically oriented and a structurally oriented conception of geography (and cultural geography) lies in the requirement established by the latter and rejected by the former that the chief focus of attention be on simultaneous, compresent phenomena, in other words, on areal differentiation. But the subject matter, in terms of classes of phenomena dealt with, is identical for both -- the ecological view expresses an interest in "the surficial connections of the three states of matter, and the actions and reciprocal reactions of the terrestrial milieu and the world of life" (Vallaux 1929:405), while the structural view expresses interest in the same phenomena _provided_ the analysis focusses on a single temporal stratum. Thus the ecological viewpoint includes the latter but not _vice versa_. Genetic studies of the evolution of regions, landscapes, and the like, studies of the sort presented here, and many others of a processual rather than structural sort, would fit in under the ecological viewpoint but not the structural. It should be stressed that studies carried out on the basis of the areal-differentiation viewpoint can as well be carried out under either definition of subject matter, and methods, paramount among which are those of cartography, would be the same under both -- except that detailed, microscopic, field investigations would inevitably receive greater stress under the broader ecological definition, as would historical geography of the genetic (i.e., non-cross-sectional) variety.

The principal difficulties inherent in the ecological definition are practical, rather than methodological. A spurious methodological issue has been raised, however. This is the question whether a "relationship" provides as valid a subject of study as a "phenomenon." (Cf. Sauer 1935:625.) If we adopt the processual view, the idea of relationships as subject matter is perfectly defensible. "Spatial relations" are structural abstractions. But processual theory defines a relationship as a concrete process, equally valid as empirical subject matter as any other variety of process, tangible or not. For example, the relationship between a forest and the underlying soil is no less measurable and real than the forest and the soil themselves.

The practical difficulties arise on two levels, that of geography as a whole, and that of cultural geography. The question on the first level is whether an ecological definition of subject matter does, in fact, provide geography with a distinctive body of subject matter. Geography as the science of the relationships obtaining among the several orders of nature focusses on those aspects of each which interrelate with others. In the case of the solid earth, it focusses on processes of interaction between the rock material and climate, surface water, plant and animal life, etc., and forms the subject of geomorphology. Soil geography considers the relationship between the soil as a class of phenomena and externally impinging forces, such as plants, animals, and parent material. Biogeography examines the interaction between a biotic community and animals, climate, soil, and other factors. In the case of cultural geography, the subject matter would be the relationship between culture and all other classes of phenomena on the earth's surface, particularly as expressed in material culture, the most tangible resultant of such interaction. Thus subject matter does exist for the field defined in this manner.

Defining the subject matter of cultural geography as the processes involved in the relationship between culture and the physical environment poses the practical difficulty of determining whether or not any given set of relationships does, in fact, exist. A definition of subject matter in these, rather than structural, terms appears to leave the way open for the entry of environmentalism. But it can be assumed that any investigator qualified to examine the variety of cultural processes which relates to the material environment is also familiar enough with culture in general to avoid the pitfalls of environmentalism. (It should be noted that one of the most fertile sources of environmentalism, which consists in a direct leap from an environmental feature to a cultural feature without consideration of process, is the purely structural correlation of a natural distribution -- e.g., flat land -- and a cultural distribution -- e.g., population.)

As in the case of geography as a whole, so in cultural geography a definition of subject matter in ecological rather than chorological terms provides a wider choice of relevant problems for the investigator; the former includes most of the latter, but not vice versa. The present study, again, only becomes one in cultural geography under the former definition. The only problems normally tackled by geographers today which would appear peripheral under the ecological definition are (1) those which describe distributions not closely tied to resource utilization, material culture, or the physical environment, and (2) those which correlate such distributions. Even the effort of the political geographer to examine the way in which an areal unit is integrated or bounded politically becomes relevant, since the "area" is a complex of associated phenomena which interest the geographer insofar as they relate to the physical environment, resource use, and material culture.

We have so far endeavored to show that an ecological definition of the subject matter of geography and cultural geography encompasses nearly all of the subject matter dealt with by a chorologically defined geography and cultural geography. It remains for us to provide the same sort of analysis for two other definitions of cultural geography: the genetic view, which focusses on the present day cultural landscape, or on a distribution, tracing these through their course of evolution up to the present; and the view of cultural geography as the science concerned with "man's role in changing the face of the earth."

We may take Sauer's "Foreword to Historical Geography" (1941) as the fullest expression of the genetic viewpoint. In many ways a modified structural viewpoint remained, either explicitly, as in Sauer's definition of goals ("the Standort or localization of ways of living"), or implicitly, as in his lack of attention to short-term, functional processes of interaction among elements. But, as to the former, "ways of living" suggests the ecological view, and, as to the latter, a paper on historical geography might well slight short-term processes in favor of long-term, evolutionary ones. Both the reference to "ways of living" and the evidence as to subject matter provided in Sauer's (and his students') substantive work suggest that the material dealt with is ecological -- material culture, resource use, and, in general, the use by culture of the physical environment. Only in the concept of localization (much less heavily emphasized in this paper than in Sauer's earlier methodological statements) is the subject of study limited in a way reminiscent of Hartshorne's chorological viewpoint. However, Sauer's heavy stress on a non-areal, i.e., non-cross-sectional, but rather evolutionary view of historical geography in no way resembles Hartshorne's (or Ackerman's) chorology.

Answering the question as to how a phenomenon came to be located where it is, as we have shown, implies the general processual question of explaining the phenomenon as a whole. If, as is the case with Sauer's implicitly recognized body of subject matter, the materials dealt with are those involved in the relation of culture to nature, it is a short step from Sauer's view to the more inclusive ecological view.

The cultural geographer as a "student of man's role in changing the face of the earth" (Thomas 1957) is neither more nor less than the ecologically oriented cultural geographer. There is no more than a semantic difference between the two: Man's role in changing the face of the earth as a subject of study translates into man's use of the surface of the earth, or his habitat, or his physical environment, which, in turn, is identical with the relation between culture and nature, since man cannot be considered except in cultural terms, and the relationship in question translates (as we shall see in Chapter III) into <u>use</u>.

We have considered four definitions of the subject matter, or scope of attention, of cultural geography. Of these, the ecological is the broadest, encompassing each of the others except the last, with which it is identical. It is also the only one focussing directly on process, treating space as subordinate to, though an important phase of, process. The subject matter dealt with in the present study would seem to fit most satisfactorily into an ecological definition.

CHAPTER III

THEORY, CONTINUED:

PROCESS ANALYSIS, FUNCTIONAL AND HISTORICAL

Process Analysis.--In the following sections a system of concepts, which we shall term process analysis will be developed for handling problems in cultural geography which concern process rather than space, and thus for the problems dealt with in this paper.

Conceptual systems can neither be proven nor disproven: Their single test of adequacy is whether or not they are useful in defining significant problems not recognized by or not accessible to other conceptual systems, in providing a framework of concepts by means of which research results can be reordered into more meaningful forms, and in pointing up methods of handling data so that they lead to significant generalizations and successively more-advanced problems. Accordingly, we shall begin by arguing the need for a processual system of concepts.

In a paper read at the 1954 annual meeting of the Association of American Geographers, Kniffen proposed a fundamental reformulation of the goals of cultural geography. (Kniffen 1954) "The ultimate objective," he suggested, "is to understand human behavior with respect to earth qualities." Thus he sought to define the goals of the field in distinctly processual terms, along lines somewhat reminiscent of Barrows' human ecology. (Cf. Barrows 1923.) The ecologists, however, failed to indicate a valid way of getting at these goals, while Kniffen proposed a program for the field which, since it draws on the methods of the sciences dealing with culture ("Cultural geography...shares the procedures common to all social inquiry"), avoids the contradictions which defeated the ecologists. Further, he showed that, of the three factors involved in man-nature relations -- man the animal, the physical earth, and culture -- only one, culture, is a significant variable at a given time and place, and he concluded that the cultural geographer "must know something of all aspects of culture" in order to understand mechanisms of habitat use.[1] And finally, he urged attention to the twin questions of explanation and prediction, suggesting the latter as our primary long-run goal, and providing concrete examples of the sorts of limited predictions accessible to us now. Kniffen's paper carried the argument for processual geography several full steps beyond where Sauer (1941) had left it, in part amplifying Sauer's proposals (e.g., those concerning culture, process, prediction) into a programmatic statement, and in part shifting the ground away from structural viewpoints.

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[1]Although Kniffen defined the goal of cultural-geographic study in processual, i.e. non-spatial, terms, he made abundantly clear the fact that many, if not most, significant processual problems in the field involve spatially extensive segments of reality -- the diffusion of a material trait, the spread through time of a culture complex associated at any given time with a specific culture area.

In the following paragraphs the outlines of a tentative conceptual system which is felt to be suitable to objectives of the sort advocated by Kniffen will be sketched in.

Subject Matter.--Among the sciences dealing with culture, or man-in-culture, only cultural geography and to a much lesser extent cultural anthropology have shown any significant interest in the major segment of human experience and behavior which relates to habitat, the perceived and utilized environment. Cultural anthropology, however, has approached the problem only peripherally: Most archaeologists concern themselves with resource utilization primarily because it is the most easily inferred aspect of culture in archaic sites, but usually do not go far beyond enumerating items of material culture; ethnographers sometimes enumerate such items, sometimes examine attitude patterns underlying economic behavior, sometimes describe resource-using behavior (usually in general, qualitative terms), and usually provide brief, generalized descriptions of habitat. A minor strain in economics, particularly in fields such as farm management and industrial location, concerns itself with resource utilization, though economics rarely descends below the abstract level of demand, costs, returns, wages, and prices. Among the "ecological" sociologists, most of whom do not define "ecology" in a resource-use sense, some few have dealt with the subject, as have an occasional rural sociologist and demographer. As a general rule, however, it can be stated that this problem as a whole is marginal to many fields and, with the exception of cultural geography, central to none. The chief difficulty appears to be a lack of familiarity with the material environment: Only geographers, among social scientists, are qualified to study and interpret the several facets of a given habitat. The problem of man-environment (or culture-environment) relations seems to have been left largely to the geographers, by default.

Yet the processes involved in man-environment relations, since they are fundamentally cultural processes, seem to provide as unified a body of subject matter as is claimed by any social science, and are certainly at least as significant for the understanding of man as any other constellation of cultural processes. It is suggested here, as it has been earlier by countless other geographers, that this subject-matter area is a logical field of investigation for cultural geographers. It is suggested further that this processual approach to cultural geography, since it possesses a distinctive body of subject matter, conforms to the classical definition of a systematic science as a discipline dealing with one particular portion of human experience and knowledge.

Classes of Process.--To begin with, it is necessary to identify the kinds, or classes of process involved in resource utilization. Resource utilization in the sense used here means the total set of cultural and physical processes involved in man's use of his habitat. A resource is defined here as any habitat feature which is recognized by the participant in a culture as being relevant to his interests. Thus there can be "positive" resources, those found useful, and "negative" resources, those which are hindrances to these interests. This definition of the term "resource" answers the present need for a term to describe segments of the total relevant habitat, which presents both favorable and unfavorable aspects in relation to the values of a given culture-sub-time. Steward's term cultural ecology, which generally delimits the part or parts of culture which relate most directly to habitat, will be employed as the biosocial complement of "resource" (Steward 1956).

Three classes of process involved in resource utilization can be distinguished. Two are cultural-ecological, the third, material. Processes of orientation, borrowing a term from action theory (cf. Parsons 1951), take place within the resource-user:

> The actor's [i.e., resource-user's] system of orientations is constituted by a great number of specific orientations. Each of these "orientations of action" is a "conception" (explicit or implicit, conscious or unconscious) which the actor has of the situation in terms of what he wants (his ends), what he sees (how the situation looks to him), and how he intends to get from the objects he sees the things he wants (his explicit or implicit, normatively regulated "plan" of action) (Parsons 1951:54).

James' phrase, "attitudes, objectives, and technical abilities," refers in a general way to the same set of processes. (James 1954:13.)

Orientation is made up of three recognizable elements: (1) the subjective understanding which the resource-user has--

his apperception--of his objective external environment;[2] (2) the values which set up predispositions to act in a given way toward the subjective environment, using the term "value" to mean

> ...a code or standard...which organizes a system of action. Value...places things, acts, ways of behaving, goals of action on the approval-disapproval continuum (Kluckhohn 1951:395);

and (3) the technical knowledge (James' "technical abilities") which permit attainment of goals. The motivation to act in a given way is made up of all three facets of orientation. It should be noted that action *vis-a-vis* resources is rarely a simple man-nature relationship: Even in the simplest of cultures most actions have a social referent, involving others directly (as in managing labor) or indirectly (as in social aims of production).

The second major group of relevant processes is that of behavior. Viewed as process, resource-using behavior has two aspects: a qualitative one, that of the kinds of behavior operations carried out by the resource user; and a quantitative one, that of the intensity of these operations, the labor input.

The third major class, and the one to which traditional

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[2]The subjectively understood environment has been termed the "psychological environment" by Sprout (1956), and the "behavioral environment" by Kirk (1951). Both terms raise difficulties: "psychological environment" has been used by psychologists to indicate internal states; "behavioral environment" suggests only behavioral interaction, not perception. In this paper we shall distinguish only between the "objective" and "subjective" external environments.

geographic goals and methods have been for the most part directed, consists of resource--that is, non-human--processes. Sprout, following Parsons, prefers to divide the objective material environment into "social" and "non-social" aspects (Sprout 1956), a refinement of the dual concepts "cultural" and "natural" landscapes, but this brings in problems associated with any attempt to dichotomize a continuous variable. (Cf. Thomas 1957.) It does not seem necessary for our purposes to make any such distinction. It is, however, useful, in certain instances, to distinguish between those resources which have merely an instrumental function (e.g., tools) and those which have a goal-satisfying one (e.g., in the present study, vegetables and livestock).

Each of these three classes, orientational, behavioral, and resource, is equally relevant. Motivations, which control and trigger behavior, arise from the interplay of perception, values, and abilities. Of the three, only the first is a short-term variable; thus, decisions as to resource-using behavior in a given culture at a given time and place vary strongly with perception.[3] We can speak of orientation as a whole as controlling behavior. Behavior, in turn, is the primary factor initiating processes of change in the objective environment. These changes provide new sense data which contribute to altered perception of the resource situation, thus

[3]Perception includes both conscious and unconscious elements, and awareness of inner states -- needs -- as well as external conditions.

affecting orientation. And so on. To explain any one facet of this integrated complex we must know something about all three.

The Process Field.--Defining the zone within which a set of relevant processes operates poses another problem. Since processes operate in time as well as space, simple spatial boundaries will not suffice. The region, according to Whittlesey (and in accepted usage), "enfolds a three-dimensional segment of earth-space" (1954:37); this concept, then, is a structural one, and will not suffice. Further, since our criterion of relevance is participation in the resource-using complex, some processes, but not others, will be relevant within a given space-time segment, and relevant processes will extend beyond its boundaries. Thus a space-time concept of the region will not suffice either, since, in addition to locating the processes in space and time, we must establish their relevance to a resource-using situation.

The concept of a process field has been used in several sciences to deal with this problem of boundary-definition, where space, time, and selectivity are involved. Stephen Jones has used the concept in political geography in dealing with an analogous problem (Jones 1954). A field of resource-using processes may be defined as the space-time zone occupied by a given body of inter-related resource-using processes. Within the space-time region in which the field falls some processes are internal to the field, others external to it. At the boundaries of the field, which are rarely clear cut, a set of processes external to, but impinging on, the field can be recognized. A field may be spatially broad ("macrogeographic") or spatially restricted ("microgeographic"). It may involve only a limited ("systematic") class of phenomena or a broad ("regional") range of phenomena. It may be temporally deep ("historical") or temporally shallow ("functional").

Functional and Historical Process Fields.--A third group of concepts is necessitated by the fact that different methods of analysis apply to short-term fields and long-term, historical fields, respectively. Over relatively short periods of time, say a farming year, or the period occupied by a geographic field investigation, our concern is with the organization of processes into a dynamic, functional system, involving the interaction of elements within the field, their response to impinging external processes, and the like. This transient system of organized processes may be termed the functional field, studied by methods of functional analysis. The long-term developmental changes which take place in and on a functional field and alter it through time will be called the historical process field, studied by methods of historical process analysis.

The term "functional," in the sense used here, is purely neutral: That is, it does not imply "use," "purpose," or other teleological or directed notions. Thus it differs both from the concept of functionalism associated with Malinowski and Radcliffe-Brown in anthropology, and from the concept of function used by geographers when they speak of urban "functions" or the "function" of a political boundary.[4] The expression "historical process" is used here in preference simply to "historical" to make clear the fact that we are dealing in spatio-temporal terms, not the structural terms associated with the concept of simple sequence.

Functional Analysis and Functional Models.--A general statement of the method of functional analysis must await the accumulation of many functional studies. For our purposes it will be sufficient to indicate the analytic stages employed in the present study. These stages do not represent chronological phases of field work, but rather analytic stages in the handling of data obtained in the field.

Stage I involves the identification and definition of functional resource-using fields. In the present study one such field was distinguished for each of the two major farming types in Singapore, leaf-stem vegetable farms and fruit-earth-vegetable mixed farms.

Stage II involves the enumeration of the individual process elements making up and impinging on a functional field. These fall into the three process classes, orientational, behavioral, and resource. (An example of such an enumeration is the

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[4]Occasionally the word will be used in the "geographic" senses referred to, but only when no other term suffices and when its meaning is clear from the context.

substantive section of the table of contents of this dissertation.)

In Stage III each process element is abstracted from its functional context and analyzed separately, to determine its intensity, its effects on other elements and the field as a whole, and so on. In this procedure an "ideal" or "typical" condition is described for each, in order to provide the basis for Stage IV analysis.

Stage IV involves synthesizing the process elements into functional models, one such for each of the functional fields. This is constructed by fitting together the idealized process elements into a simplified, idealized field, one which can be used for prediction purposes by altering any one, or several, of its component processes and examining the probable changes on the whole which result.

Using functional models it proved possible to discover "tension points," or key process transactions, in each of the farming systems. In the leaf-stem system, that described here, one such tension point was hand-watering of vegetables, one of the most time- and effort-consuming behavioral elements. Its importance suggested that the primary reasons for the small average size of farm in the Lower Kallang Plain -- six-tenths of an acre -- was labor shortage rather than, as might normally be expected in such a situation, land shortage.

Historical Process Analysis.--The present study was concerned primarily with the contemporary situation, and functional analysis played a significantly greater role than did historical process analysis. In this work historical process analysis proceeded by projecting through time the two major functional fields, the goal being to examine the changes which had taken place in the two systems and their elements, and to examine external processes which brought about these changes.

It proved desirable, first of all, to establish an arbitrary "birth date" for the functional fields, the place and time when either (1) the fields could first be picked up in historical records or (2) they achieved an identity recognizably related to the present situation. Secondly, the spatial and temporal movements of the fields were traced from their presumed point of origin to their present location in Singapore. And finally, changes which had taken place in them, and the factors producing these changes, were investigated.

CHAPTER IV

THEORY, CONTINUED: SOME IMPLICATIONS AND APPLICATIONS

Utility of the Theory.--The idea that substantive research can be carried on in the absence of a supporting body of theory, whether or not the significance of the theory is explicitly recognized by the researcher, is false. This applies both to his conception of the nature and purpose of research in his field and to the conceptual system he employs -- the two are, indead, closely related. One's definition of the field, with its implied prescriptions as to "proper" sorts of research and the goals of research, strongly conditions one's work. It seems clear that many of the excesses of environmentalism were due in large measure to a conception of geography as the search for environmental causes for human responses. Similarly, much of the arid -- the valuative term is intentional -- description of recent decades appears to result from a conception of geography as primarily concerned with stating "what" is located "where" -- a conception based on the etymologically proper but scientifically questionable definition of geography as merely "earth description." And finally, some, though by no means all, of the work which has been based on a conception of geography as concerned with the genesis of regions, landscapes, material culture, and the like, has, precisely because "genesis" rather than "explanation" underlies the viewpoint, resulted in a kind of chronological historical geography which is as structural -- i.e., divorced from process or space-time -- and therefore arid, as studies of simple distribution, merely substituting in this instance the time-abstraction for the space-abstraction.

But the conceptual system underlying a piece of research is equally implicated in the nature and results of that research. To begin with, substantive research seeks out "facts." But "facts" are something more than raw sensory data; they are data fitted into a conceptual scheme; they are, in a word, concepts. To use a simple illustration, a given array of houses in the landscape may lead to any of several concepts of settlement pattern (a generic concept in itself), depending entirely on the scheme of classifying settlement patterns which the investigator has in mind. The houses themselves may be conceptualized in one way or another, depending on the scheme of classifying house-types which the investigator uses. It is correct to say that concepts, which for our purposes may be defined as the grouping of raw sense data, are implicit at all levels of research, and that these fit in all cases into an implicit or explicit, logical or self-contradicting, conceptual system.

Conceptual systems at a higher level of generality than "settlement pattern," "basic-non-basic industries," or "mode of resource use," are the subject of our attention here. The present paper has developed a system of concepts which (1) abandons some of the notions that derive from concepts of simple spatial location and simple temporal sequence, and substitutes for these an alternative set which derive from concepts of process, (2) is operationally useful, and (3) is logically consistent. The first involves avoiding such concepts as "spatial phenomena," "areal relations," and "sequent occupance," and substituting "spatio-temporal phenomena," "functional fields," "historical process," and the like.

The operational utility of the theory can be found in several of its implications. First of all, we have argued that it leads us out of channels of thinking which end up either with simple spatial description or simple chronological description, neither of them serving as a means of explaining phenomena (although, of course, each serves as a preliminary step in explanation). Secondly, as has also been pointed out, a conceptualization of our field in terms of process provides cultural geography with a distinctive and unitary body of subject matter, since on the one hand, it redefines "relationship" in such a way as to eliminate its objectionable, environmentalistic, connotations, using the term only as a designation of processes whereby environmental materials are put to human use, and, on the other, it focusses on a body of processes, those involved in resource use, as the core subject matter.

Finally, and perhaps most important, it holds promise of leading to new insights into the general problem of man-nature relationships, since it focusses our attention more closely on this problem while at the same time eliminating the blind alleys (descriptive and environmentalist) which have in the past blocked our attack on it. In this connection, it provides an operational means of introducing the concept of culture into the question, a necessary condition of explanation in this field, as Kniffen has pointed out. Further, it holds promise of leading into factual generalizations as the conceptual categories it sets up are transformed into meaningful, verifiable propositions concerning the concepts and relations between them. For example, by calling attention to the factor of orientation, it suggests a variety of substantive problems designed to examine the role of motivations in cultural-geographic phenomena; one study along these lines has already been initiated.[1] And by treating behavior as a conceptual category needing careful, quantitative treatment in the search for explanations, it has led to the rather unusually detailed analysis of farming behavior in the present study. (See especially Chapter XVI.)

Process Theory and Sociocultural Theory.--It seems desirable to reemphasize at this point the fact that an attempt such as the present one to build a conceptual theory is more than simply an exercise in the philosophy of science. Concepts, as we have indicated, are viable only if they are useful. The uses of the system elaborated here are twofold: first, to tie cultural-geographic theory more firmly to what

[1]During the summer of 1957 the writer, with three colleagues, undertook a program of research on "cultural determinants of soil erosion and conservation" in the Blue Mountains of Jamaica, one of the essential aims of which was to determine the culturally derived motivations leading to erosion-inducing behavior and lack of acceptance of conservation measures.

must be its roots, general sociocultural theory, and second, to utilize it as a means of developing meaningful and verifiable hypotheses which are themselves useful -- in leading to further hypotheses and perhaps, ultimately, to broad-scale generalizations.

As Kniffen (1954) has shown, the only significant short-term variable in resource use is culture; it is not nature, and it is not man as genetically constituted. There is no need to argue here over a definition of culture, or re-open the somewhat fruitless questions of the (culturally-nurtured) individual versus (individual-borne) culture. It will suffice for us to point out, on the basis of Kniffen's postulate, that explanation, the analysis of causation, must be based on an understanding of socio-cultural mechanisms in any given geographic study, since these mechanisms, as they operate through resource-using individuals, are the immediate causes of essentially all resource-using situations. The fact that an individual makes a decision in terms of an awareness of environmental possibilities -- possibilities present in the apperceived subjective environment, not the objective environment -- and the fact that a multitude of such decisions may suggest some strong correlations between environmental circumstances (e.g. flat land) and resource-using behavior (e.g market gardening), should not be taken as evidence that the causal lines can short-cut around cultural determinants: The relationship is only permitted by these determinants, which yield the subjectively apperceived environment, the values, and the technical knowledge underlying resource-using decisions and behavior.

Since, therefore, causation in cultural geography ultimately rests on causal processes in culture, a conceptual system for analyzing the former must be tied securely to conceptual systems underlying the latter -- the former is merely one special case of the latter. A few words on the process whereby the theory presented here is tied to some aspects of the more general sociocultural theory are in order.

As indicated above, we need not take sides in the question of the ultimate priority of the individual or culture. The present theory is framed in terms of the individual -- his motivations, decisions, and behavior, and their determinants -- but this merely reflects the need for the formulation of concepts at a level which can lead to meaningful analysis in actual field research, the level, after all, of individual resource-users. In view of the "pitch" of these concepts, it will be easiest to examine their relationship to general concepts focussing on the individual's relation to his total environment, rather than the more abstract level of culture-as-such.

Parsonian action theory, a relatively recent synthesis of several trends in sociocultural and sociopsychological theory, has evolved a system of concepts describing the various terms in an idealized network of individual-environment relationships. The environment here is the totality of what Parsons and his co-workers (1951) call the "situation."

Elements in the field (for that is what it is) are ranged on two sides of a boundary between the individual (the "actor") and the situation. The conceptual system encompasses action by one individual, a kind of autecology, and actions by groups of interacting individuals, analogous to synecology. Unfortunately, so far as the writer has been able to determine, situational elements other than actors themselves have not been analyzed in this system, being lumped in a general category of physical objects present in the situation. They are shown to have meanings of various sorts, but emphasis is on symbolic meaning rather than on their role as objects of direct cathexis, goals of the individual's behavior -- or, in the present terminology, as resources. In cultural geography, or at least in process-oriented cultural geography, we are concerned most with this problem of the individual's relationship to physical objects, and only secondarily with his relationship to other actors. However, the general Parsonian concepts describing an actor's relationship to his total situation seem to apply nicely. From the standpoint of the individual, these are the processes of "orientation" discussed in Chapter III; they include the apperceptual, valuative, and technological elements involved in motivations, whether the latter refer to resource-using or other behavior.

Thus process theory in cultural geography can be considered, from one point of view, as an attempt to deal with resource use in such a way as to place it within a general framework of individual-situation relations, making it a special case of the latter. It appears to fall within the category of theories which Merton (1949) calls "theories of the middle range," those which lie at a lower conceptual level than general sociocultural theories (among them the "structural-functional" theories of which action theory is one), but higher than generalizations concerning specific bodies of data. The present theory describes general participating elements in resource use, and their relationships at the most abstract level.

The form taken by the concepts of process theory is such as to make rather difficult a meshing of this approach with concepts of culture other than those which focus on the individual. If culture is viewed as a "screen between man and the world around him" (Krader 1957:iii; cf. also Linton 1936:467), or as a set of learned determinants of behavior, no problem exists, since the present viewpoint focusses on just such a set of cultural or culturally derived determinants of one major class of human actions, those relating to resources. It would appear that some form of "reductionism" is necessary for the use of the present theory, but it is only necessary because the theory is pitched at the level of analysis dealing with specific individuals possessing specific histories, those who are studied in a field research problem in processual cultural geography. It does not follow that we need to abandon the more abstract notions of culture as a structured whole which dictates the attitudes and behavior of individuals.

Perhaps, when a fully developed processual research problem appears in print it will have attained a level of analysis permitting generalization to a culture as a whole, abstracting resource-using roles and institutions from the particular behavior of individuals. The writer would not care to predict the possibilities for analysis of this sort at the present time.

CHAPTER V

METHODS: THE MICRO-REGIONAL SURVEY

Choice of Methods.--The research operated at several levels of intensity. The principal effort consisted of a moderately detailed micro-regional survey of some 375 farms, about 250 of which were leaf-stem vegetable farms and therefore relevant to the present paper. This survey was intermediate in scale of intensity between a cursory, re-connaissance farm census and a highly detailed case study of one farm, both of which it preceded. The micro-regional survey represented the core of effort of the work; the subsequent census and case study, respectively, aimed at quantitatively generalizing and qualitatively intensifying its results.

The Problem of Sampling.--In theory, probability sampling should be employed in a micro-regional study of this sort. (Cf. Blaut 1954b.) If a list of farms (from tax rolls or other sources), a map identifying individual farms, or air photos showing the farms were available, any of several sorts of probability samples could be pre-selected. Stratification could be employed if any basis existed for classifying the farms according to characteristics relevant to the study. If, on the other hand, no such list, map, or photo were available, a second and somewhat cruder sampling procedure could be employed. This procedure, known as "area" or "cluster" sampling, requires merely a division of the total area into equivalent areal units, and sampling of the units by simple random or stratified random procedures. One form of area sampling involves the construction of a square grid over the area and sampling of individual squares. (Stratification here would be based on the known relevant characteristics of each grid square; the squares would be classified according to these characteristics and a simple random sample drawn from each class, thus reducing variability and sampling error.) Another form involves the construction of point-locations, at grid intersections or otherwise, and the sampling of these point locations by simple random or stratified-random procedures. In the first case a unit area is blocked out and all or a certain proportion of farms in the square are studied; in the second case no areal boundaries are provided and field work proceeds outward from the point-location to include a specified number of the closest farms.

The strategy first considered for the micro-regional survey involved area sampling. The choice of this rather than some other probability-sampling method was based on two circumstances which obtained. First, no list of farms existed, no map showing individual farms was sufficiently up-to-date to be of any use-- cadastrals, where they existed at all, were twenty years old and bore no resemblance to current patterns-- and the air photos of the island could not be used to distinguish precisely the typically one- and two-acre farms, many of which had their farmhouses hidden under fruit trees. Thus pre-selection of the sample farms could not be undertaken. A second circumstance related to the desirability of studying farms in localized groups rather than in isolation, since farms in Singapore frequently occur in small blocks or lines whose over-all features, such as covariance between farming system and soil or relief, and relation to a regional marketing focus, are important and cannot be discovered by studying only one farm in a given block. Thus, if any probability sampling at all were employed it would have had to be area sampling.

But even area sampling requires a certain amount of prior information. For one thing, the investigator must be certain at the start that he has sufficient resources to cover adequately a sample of a given, pre-determined size. A fundamental principle of probability sampling is that the initial sample (of area units in this case) must be selected in advance and all, or nearly all, sample units must be studied. (The sample can, of course, be expanded subsequently.) The initial appropriation for the present research was insufficient for a sample at the minimum level of adequacy--one which would have a sampling error small enough to allow meaningful generalization. The fact that subsequent appropriations enlarged the scope of the work did not help; the decision as to sampling design had to be made at the outset.

The writer considered undertaking area sampling even so, in expectation of receiving the needed funds as the work progressed. A number of discussions were held with Dr. You Poh Seng, Lecturer in Economic Statistics at the University of Malaya and a specialist on area sampling, on the possibilities and techniques of this form of sampling. In the end, it was decided that the problems confronting such an effort were too formidable: Even if funds were to be forthcoming, practical obstacles, apparently insurmountable ones, would remain. As an absolute minimum in area sampling, and in all other forms, one must be able to select a position (point location) or line (side of a grid square) on a map and then find it in the field, so that the area chosen will, in fact, be the area studied. This establishes two requirements: first, maps or air photos which conform reasonably well to ground conditions; and second, field assistants capable of working with the maps or photos. Photos were available, but two problems decided the writer against their use: The government could not guarantee a schedule in reproducing them which would ensure our having the needed ones in time; and the student field workers had had little prior experience with air-photo interpretation--not all had had geography, and, among these, few had used air photos extensively in the field. It did not seem feasible to train them in photo-interpretation in the limited time available. As to maps, the only ones existing in 1952 were topographic sheets dating from 1937, showing minimal land-use information but unreliable in essentially all features except relief. During the intervening years a number of major changes in land-use patterns had taken place: A network of military access roads had been built during the defence of Singapore, and these obscured thoroughly the pattern of roads shown on the maps in several areas; urban areas had expanded considerably; the areal pattern of smallholder cultivation had changed drastically; and, most important of all, the form of land use shown as most widespread on the topographic maps, rubber plantations, had been replaced over much of the island by <u>blukar</u> (secondary bush) as a result of cutting. Under these circumstances, it is no reflection on the geographic training or abilities of the students who served as field assistants to say that they could not be expected to find point-locations or boundaries of grid squares in the field, since many parts of the island bore no resemblance whatever to the topographic maps. Even the writer has been baffled many times in the island's interior trying to ascertain whether he happened to be in one or another offshoot of a given drainage system, or on one or another of the nearly identical low hills, when the landscape shows only unmapped <u>blukar</u> and unmapped military roads.

And finally, the culminating obstacle was lack of transportation. Only one vehicle was available at the outset, a large weapons-carrier capable of handling the entire field group. To make circuits of the island to drop off and later pick up teams at selected points along the roads (from which they would have gone into the farming areas, often a mile or more away) would have required devoting about two-thirds of the 6-hour field day to transportation alone, roughly halving productive work time. (As it happened, six months later, during the final phase of the work, a supply of fifteen government Landrovers, with drivers, was put at our disposal, but by then the micro-regional survey had been completed.)

Incidental "Samples".--Guilford (1950:180) defines an incidental "sample" as one "taken because [it is] the most available." Generalization from such a "sample"-- not a true (probability) sample in the accepted statistical sense -- involves, according to Guilford, "considerable risk," unless it is known that significant properties of the sample correlate with the selected farms to be studied in the present micro-regional survey can be called incidental sampling: It aimed at obtaining as representative a body of farms as practical conditions permitted. However, once the hope of obtaining true representativeness, of the sort only possible with a probability sample, had been abandoned, other criteria for selection became important. One such was the aim of obtaining a sizeable group of farms from each of the major farming types found on the island. Another was that of studying large blocks of contiguous farms, for four reasons: (1) to simplify the problem of transportation, and that of administration of field work; (2) to deal with a cluster of farms which, being contiguous, would tend to be similar, thus providing cross-checks of the accuracy of data from any one farm; (3) to deal with a group spread over a broad enough area to reveal differences based on slope (and soil catena) in the upland areas, drainage in the lowland areas, and both in the combined upland and lowland area; and (4) to cover a block of farms which functioned to a certain extent as a macro-regional unit, with relatively integrated marketing patterns, or water conditions, or price conditions. A third criterion for selection was the aim of choosing blocks of farms which represented the most, or nearly the most, concentrated examples of each type--i.e., the largest blocks of contiguous farms of each.

Selection of Areas.--Seven such farming areas were finally chosen, three of which emphasized leaf-stem vegetable cultivation and are therefore relevant to the present paper. The most significant of the seven was the Lower Kallang Plain, a specialized leaf-stem vegetable farming region largely within the city of Singapore itself. A second was the Middle Kallang Plain, separated somewhat arbitrarily from the preceding by a road crossing the plain, and representing a transitional zone between the heavy soils and leaf-stem vegetable cultivation of the lower plain, and the sandier soils, with mixed pig and fruit-earth vegetable cultivation, of the upper plain. A third, the Central Lokyang area, consisted of an irregular line of farms associated with the drained Sungei Jurong swamp of the eastern portion of the island. The central segment of farms here was, again, a leaf-stem vegetable-producing region, having a curious "catena" pattern with leaf-stem vegetables grown along the edge of the swamp and other crops higher up, pig pens and farm houses being at the upper end of most farms. Jalan Tiga Ratus (the pilot survey area), Yio Chu Kang, and two areas respectively north and south of the central Lokyang area, were the four mixed-farming (non-leaf-stem vegetable) areas studied. The island map (Map 1, in pocket) shows the location of the three leaf-stem vegetable areas. The approximate number of farms studied in each of the regions is as follows: Lower Kallang Plain 160; Middle Kallang Plain 65; Central Lokyang "Catena" Region 25; Lokyang North 25; Lokyang South 25; Jalan Tiga Ratus 60; Yeo Chu Kang 20.

Data Sought.--The micro-regional survey, as indicated above, formed the core of the field work, both in terms of the breadth of data collected and the qualitative and quantitative intensity sought for these data. The major effort was devoted to a single visit to each farm, with data collected by interview, observation, and mapping. In addition, repeated visits to certain of the farms over a period of six months, and subordinate operations--soil mapping, regional activity cycle analysis, recording of rainfall, and the like--broadened and intensified further the scope of the micro-regional survey.

Data sought on the individual farms covered the entire range of material and behavioral features relevant to resource use on the farm, and certain information on orientation (motivations) as well. These data fell into, roughly, the following classes:

(1) The farmers and farm families: Size and composition

of the family; farmer's cultural and locational origin (and that of his father); farmer's prior occupations; length of time on the farm; secondary employment off the farm; etc.

(2) Crop and stock types and their combinations (farm enterprises).

(3) The physical environment: soil texture, structure, horizon development, aeration, and moisture relations; slope; drainage (including depth of water table).

(4) Size, shape, and areal differentiation of the farm in terms of land-use classes (farm structures, fields or beds of vegetables, access paths, ponds, pig pens, fruit trees, etc.).

(5) Kinds, quantities, and cyclic occurrence of productive tasks (watering, tilling, marketing, harvesting, fertilizing, etc.).

(6) Soil and crop changes during the crop cycle for each variety.

(7) Yields.

(8) Capital equipment -- tools, productive farm structures, vessels, etc.

(9) Material input factors -- seed, hand-applied water, fertilizers, pesticides, young stock, etc.

(10) Costs and returns, including crop receipts, livestock receipts, value of farm privileges, production expenses, marketing expenses, upkeep expenses, and other economic data needed to establish (a) size of

farm business, (b) disposable income (farm income, family net income, labor earnings, etc.), and (c) productivity.

(11) Other socio-economic data such as tenure relations, indebtedness, etc.

(12) Farmers' attitudes toward soil quality, "ideal" productive behavior patterns, impinging external conditions (prices, floods, etc.), and other topics relevant to the question of motivations.

Field Procedures: The Initial Survey.--The foregoing list includes items sought during the primary visit to a farm, during later visits, and in other ways. The most difficult problem in the entire research was that of obtaining reliable data on the above topics; therefore a somewhat detailed description of the procedures worked out to do so would not be out of place here.

Field work began with a twelve-day pilot project in the Jalan Tiga Ratus area, during the University of Malaya's spring vacation, with ten students participating. The principal aims of this initial phase of the work were to evolve a workable plan for gathering data and to train student-investigators. It became clear during the course of this project that three main field tasks were involved: interviewing, observing, and mapping. These tasks were found to occupy a considerable period of time (six man-hours) for each farm, since what amounted to a full cultural-geographic and farm-management analysis was being undertaken. To limit the actual contact time, and thus avoid the possibility of encountering farmers' resentment on this score, it was felt that groups of three investigators should function as teams. One investigator prepared a pace map of the farm and carried out certain other observations, the second interviewed the farmer, and the third recorded farmers' answers and carried out observations while doing so. The division of labor into interviewer and recorder was decided upon (partly on the advice of the students themselves) for several reasons. First of all, farmers exhibited a certain amount of embarrassment when the interview was carried out with a definite sequence of specific questions, and with frequent breaks while answers were recorded by the interviewer himself -- the act of writing down his answer tended particularly to make the farmer nervous. If, on the other hand, the interview was carried out in a conversational manner, with a recorder in the background flipping pages in the schedule to whatever question was being dealt with at a given moment, better rapport was achieved: The writing down of answers was less conspicuous, and a partly unstructured interview was obtained. A second reason for separating the interviewing and recording function was based on the multiplicity of dialects and languages spoken by farmers. Farmers in the Jalan Tiga Ratus area spoke either the Teochiu or similar Hokkien dialect, sometimes also simple Malay, but never English. Most students could converse in these dialects, but others, who spoke only Cantonese, Malay, or Tamil (in addition to English) could not. Not all field teams could have two Hokkien-Teochiu speakers. (The third member, the mapper, did not have to speak the dialect, of course.) In such cases the interviewer would translate the farmer's answers, usually into English since the schedules were in English. When the project shifted to Cantonese areas, team personnel were shifted so that each team had a Cantonese-speaking interviewer and as many teams as possible a Cantonese-speaking recorder as well. This proved to be the most efficient way to utilize available manpower.

The entire interview-observation-mapping operation took an average of two hours on each farm. This unusually long period of time for a single visit was disadvantageous from several points of view, but experiments with other approaches in the pilot project proved that, under the prevailing conditions, no alternative was possible. A shorter visit was ruled out by the necessity of asking each of several quantitative questions a number of times in different ways, a procedure made necessary by the fact that farmers kept no records. Returning several times to the same farm, instead of carrying out the operation in a single visit, would have complicated the administrative problem, and seemed, when tested, to result in a poorer second interview because of farmers' resentment at having their time taken up a second time.

A facsimile of the interview questionnaire finally arrived at will be found in the Appendix. Interviewer training eliminated the need for using this list of questions; a schedule consisting only of summaries of the questions followed by blank tables for filling in information was used by the recorder. An example from one of the questions is the following:

FREQUENCY OF FERTILIZER APPLICATION

Crop	Kind	Frequency

As indicated above, some of the questions had to be asked a number of times. Three different methods of obtaining total annual yields were employed, and eight questions attempted to arrive at quantity and value of fertilizers used. Even so, adequate answers to these questions were not obtained in all cases, and a number of other techniques, described below, had to be used.

On each farm one bed of vegetables was selected for intensive study. It was while the students and farmer were standing over this bed that most questions on farming operations were asked. Quantities of fertilizer, water, seed, applied to the bed, length of the crops cycle, and similar data, were also sought. Through a serious oversight the yield from the bed for an average harvest was not inquired into: It later developed that bed-by-bed estimates were often more reliable than day-to-day or annual ones, and this important source of information was overlooked.

The mapper prepared a pace map of each farm; Maps 4, 5, 6, and 7 are redrawn from such pace maps and Map 7 indicates the information provided on them. Lack of compasses proved a problem for the upland areas, with their large, irregular-shaped fields, and areas (and yields) of fruit-earth vegetable crops grown on these fields are less reliable than might have been possible with precise determination of angles, but all beds of leaf-stem vegetables were relatively straight and narrow, eliminating the problem of eye-estimation of angles. On upland farms the mapper also estimated by eye the difference in elevation between the highest and lowest points on the farm (never more than six to eight feet, and usually below five) and recorded positions of the high and low points on his map. He estimated the age of crops in each bed or field, the number of fruit trees, pigs, and chickens, and the total area under each crop, and indicated the position of the bed selected for intensive study. On farms having both flat and sloping land he indicated the break of slope.

The problem of attaining rapport was, of course, a basic one. Techniques employed included some used in all areas and some designed for a particular area. Special instructions were given field teams on certain points of conduct. For example, teams were to accept an offered cup of tea (after polite protest), but not gifts, since the former is a customary gesture of hospitality while the latter is a standard form of petty bribery in farmer-official relations. Team members, where possible, carried pocketsful of candy for the farm children -- a very effective device for gaining rapport with the adults. Most important of all, interviewers were required to state clearly that we were a group of students and a teacher making a survey for our university (well-known throughout the island), and had <u>no connection with government</u>.

This was approximately true, since our financing had had no strings attached. Our concern with avoiding any identification with the government resulted from evidence in the test survey that some farmers tended to exaggerate their expenses and debts when they thought we might help them gain government assistance (as, for example, in obtaining priority in having their chickens innoculated against ranikhet disease), while others exhibited ill-concealed apprehension as to our purpose in conducting the survey, fearing a connection with taxes or conscription. Another cardinal point: The writer had obtained a commitment from the Singapore government not to use any information supplied by the farmers for an action applied to individual farms, and our interviewers could honestly assure the farmers that the information they supplied would be kept in strictest confidence. (In all cases but that of Mr. Ng Hong, who gave us permission to use his name and publish data concerning his farm, farms were referred to only by number, to comply with this promise.) And finally, traditional courtesy was emphasized, partly through selection of interviewers (usually by team vote) for their possession of suitable personality qualities, and partly by frequent reminders of the importance of this point.

One common technique of gaining rapport was deliberately rejected after being tested. This is the procedure whereby a government official introduces the investigator to a prominent individual in the community, who then introduces him to others. We found that the "prominent individuals" in the two cases encountered were the local shopkeeper and the largest farmer in the area, respectively. The former turned out to be the local banker and creditor as well; the latter, landlord to quite a number of farmers. Direct contact with the farmers seemed more likely to develop honest answers on income and expenses. Although official introductions were not secured, unofficial ones were obtained in the not uncommon instance where a farmer came from the same area (even village) in China as did one of the investigators; in such cases the contact would be used to secure introductions to other farmers.

After the test survey, three techniques were used to advertise the work in advance of our arrival in an area. "Rediffusion," a British type of radio broadcasting employing telephone wires and renting out receiving sets, has extended its lines throughout the city of Singapore and included the Kallang Plain area; since farmers did not have to buy the receivers, and since most broadcasts were in Chinese dialects, the majority of Kallang farmers subscribed. Arrangements were made with the Rediffusion organization to have an announcement of our survey broadcast as news several times a day for several days before Kallang farms were interviewed. Secondly, a news story about the survey was carried in the Sin Chew Jit Poh, most prominent Chinese newspaper in Singapore, for June 29, 1952, and each interviewer carried a copy of the edition around with him to show literate farmers. And finally, several of the most diplomatic interviewers went into regions ahead of the main team to chat with farmers at their farms and in coffee shops, requesting their permission to be interviewed and explaining the purposes of the survey. Whether or not all farmers wanted to be interviewed, their innate sense of courtesy forbade refusal in every case but one.

To avoid interfering with the rapport established between interviewers and farmers, non-Chinese participants, including the writer, when they were engaged in activities other than mapping the farms, deliberately stayed away from parts of each region where interviews were in progress. The writer made his headquarters in a local coffee shop when he was not engaged in field observation. Field teams departed from this point on arrival in an area each morning and assembled there before leaving the area. Since each team had been assigned a block of farms, covering several days' work, only occasionally did they have to return to the coffee shop during the working time. Completed interviews were collected at the end of the field day; these were reviewed by the writer, whenever possible the same evening, and returned with comments.

During the period of field work in a given area, two major and several minor projects were undertaken in addition to those involved in interviewing, observing, and mapping the farms. One of the former was a soil survey: Two students were given the special job of carrying out this work under the writer's direction. A second, undertaken only in the Kallang

Plain, was the "activity cycle" analysis. This consisted of hourly walks along a selected route paralleling the Kallang River, observing all individuals between the route and river who were engaged in farming operations (all of which took place out-of-doors). Records were kept of the number of men, women, and children engaged in each task: watering, weeding, tilling, planting and transplanting, harvesting vegetables, harvesting seeds from special beds, fertilizing, applying "burnt earth" (see Chapter XVII), spraying pesticides, preparing plots of water cress, feeding pigs, collecting pig fodder, transporting crops, and other tasks. This study was terminated for lack of available manpower after hourly records had been obtained for three full days, from 6:00 AM to 7:30 PM. A third major project involved the tabulating of results. A team remained at the university transferring answers from the field schedules onto master tables and obtaining totals and averages, for later analysis. Minor projects included the following: check interviewing; recording interviewed farms on an air photo (two students having been trained in photo-interpretation); recording readings on the three rain gauges placed in farming areas during the survey; and making pace maps of small clusters of shops in the farming areas.

Field Procedures: The Follow-Up Survey.--On each schedule filled out during the initial survey the farmer was given letter ratings as to his "cooperativeness" (willingness to supply answers, and probable reliability of answers) and his apparent knowledge about his farm (admittedly an elusive point). For those farms rated "A" on both, interviewers were asked either to recommend or not recommend the farm for return visits. On the basis of these recommendations, and the farmers' responses to the interview question "Would you mind our returning next week to find out how much you produced during the week?" twenty-eight farms were selected for the follow-up study, twenty of them from the Kallang Plain, five from Jalan Tiga Ratus, and three from Lokyang. It will be noted that the "sample" was not based on criteria of representativeness.

Follow-up analysis had three aims. The first was to obtain continuing yield data over a six-month period, and farmers' prices during that period. The second was to obtain average yields on selected beds -- a procedure neglected during the initial survey, it will be recalled. The third, and perhaps most important, was to provide a vehicle for obtaining detailed answers to important qualitative questions -- the sort not requiring regional averages -- which had not been covered adequately in the less-intensive initial survey. Interviewers were advised to ask one of the latter sort of question of each farmer on each visit, and record answers as fully as possible. (Questions from this phase of the work are listed in the Appendix.)

Selected farms were visited from one to fifteen times during the six-month period 10 July, 1952 - 16 January, 1953, the twenty-eight farms having been reduced to four by the latter date as a result of decreased survey personnel, drop from "A" to "B" in the farmer's rating, and changes in the status of farms -- outside employment, failure of the farm (this having been a period of exceptionally low prices), and other alternatives.

Reliability and Completeness.--Reliability and completeness can, perhaps, best be summed up by quoting from the writer's report to the Singapore Government on the Lower Kallang Plain study:

> This survey, in common with all such carried out in areas where farmers have had little association with the agricultural agencies of their government, and where low literacy rates discourage the keeping of records, has encountered characteristic difficulties in obtaining data. Farmers gave freely of their time and provided, on the whole, honest answers. (Only one interview was refused in all six areas.) Checks of various sorts eliminated most unreliable answers. However, completeness, the "response ratio," was well below the maximum. Since farmers keep no records, and buy and sell frequently, in small and widely fluctuating amounts -- a typical farm will sell the yield from one or more vegetable beds daily, for example -- estimates of long-term production, receipts, expenses, etc., were rarely accurate. The standard unit of farm management research, the year (however reckoned), had to be eliminated entirely from questioning, and only later resurrected in the calculation stage. By using daily averages and ranges of yields from beds, as well as by other means of obtaining normals for units of one crop cycle, and by asking each key question on yield and fertilizer application rates several times in different ways, adequate approximations were obtained for key values. Since the total population of farms was covered, it is felt that the level of completeness and accuracy obtained proved adequate for analytic purposes and for generalizing, predicting, and applying the results to agricultural improvement planning. (Blaut 1954c:4.)

CHAPTER VI

METHODS, CONTINUED: THE RECONNAISSANCE FARM SURVEY

<u>Relation Between the Reconnaissance Survey and the Micro-Regional Survey.</u>--During the University of Malaya's 1952-53 Christmas vacation an attempt was made to obtain basic information on all farms on the island, to provide a means of generalizing certain micro-regional data. Logically, an island-wide census of this sort should have preceded, rather than followed, the micro-regional survey, since it would have provided the information needed for probability sampling -- a list of farms, and a basis for stratification. Probability sampling, in turn, would have permitted a much smaller total size of sample, as well as island-wide generalizations with a known sampling error, and thus would have justified the initial effort devoted to the census. However, we were unable to carry out such a census at the start because of the financial problem discussed in the Introduction, above: Funds initially appropriated, up to the end of the fiscal year (July 1st--two weeks after the main study began), were insufficient for both a census and micro-regional survey, and lack of foreknowledge regarding future appropriations decided the writer in favor of the more important of the two projects.

A reconnaissance farm census did, however, serve several important functions, even though it was not completed, was undertaken after the micro-regional survey rather than before, and was not attached to a representative sample. Most important of all, it provided a means of determining whether certain features of the farms studied in the intensive survey were even moderately representative. (For example, 80 per cent of the leaf-stem vegetable farms in the Lower Kallang Plain "sample" were operated by Cantonese, yet the inference that this farming system is very largely a Cantonese one proved incorrect when it developed that only 40 per cent of the farms surveyed in the census were Cantonese run.) Secondly, the reconnaissance survey permitted a number of tentative generalizations to be made for the island as a whole from the micro-regional data. The method used, termed here that of "linked correlations," involved the following steps: (1) determining that a significant correlation existed in the micro-regional "sample" between two features "A" and "B" one of which ("A") could be determined relatively quickly, and the other ("B") only after intensive interviewing; (2) calculating the regression curve for <u>sample</u> farms between "A" and "B"; (3) determining "A," the more easily arrived-at value, for all farms covered in the reconnaissance survey; (4) calculating the mean of "A" for <u>all</u> survey farms; and (5) projecting this mean value for "A" onto the A-B regression curve of the sample to determine the corresponding position of "B," the unknown for the survey population. A refinement of this method would employ multiple correlations, to take into account other factors correlating with income (the unknown) -- soil and family size, for example. But data from the census were felt to be insufficiently precise to justify such a refinement.

All told, 502 leaf-stem vegetable farms were surveyed in the reconnaissance farm census. This figure represents very roughly five-sixths of the estimated total number of farms of this type in the island -- far short of total coverage. Financial complications, again, accounted for this lack of completeness, as is explained in the Introduction.

Data Sought.--Two major classes of data were involved in the reconnaissance survey: those based on brief observation of a farm, and those derived from a short interview. The first class included material on soil and slope, major crops, and kinds and approximate number of stock. The interview data fell into the following classes: (1) Number of people dwelling on the farm ("slept here last night"); (2) total farm area to the nearest acre or, in the case of farms smaller than one acre, half acre; (3) farmer's dialect or (if non-Chinese) language; (4) number of pigs, chickens, and other types of stock on the farm at the time; (5) most valuable single product (e.g., a given crop, or pigs, or fruit trees) during the preceding year; (6) major source of income as among ground crops, tree crops, and stock; and (7) whether or not the response as a whole was reliable, in the interviewer's opinion. Observation specifically covered the following: (1) texture of cultivated soil generalized into three classes "clayey," "sandy," and "intermediate;" (2) soil color, generalized into the four classes "reddish," "yellowish," "light greyish," and "dark grey or brown;" (3) relief of cultivated land, generalized into the four classes "low-land flat," "upland flat," "gently sloping," and "steeply sloping;" (4) major upland crop, if any, by eye-estimation of area; (5) major flat lowland crop, if any, by eye-estimation of area; (6) areal ratio of upland to low-land crops; (7) areal ratio of ground crops to tree crops; (8) whether or not upland crops consisted solely of one or both of the two pre-eminent fodder crops, cassava and sweet potatoes; (9), determined only if no interview was obtained, whether or not the farm had a pigsty; if so, the number of pigs by rough count; and whether or not a "significant" number of chickens-- twenty-five having been set rather arbitrarily as the dividing point-- was present; and (10) which among the four classes of enterprises, leaf-stem vegetables, fruit-earth vegetables, stock, and tree crops, were present on the farm. Observational items (1), (2), (3), and (10) allowed for multiple answers: For example, a farm might have both flat and sloping land, clayey and intermediate soil, and two or more enterprises.

From the foregoing, it will be seen that the census sought a broad range of data, but allowed for little intensity on any one subject. The observational data were designed primarily to define the farming system in each case; the interview data, to obtain minimal additional information needed for the linked correlations discussed above.

Field Procedures.--The first stage of preparation for field work involved careful study of air photos to determine areas likely to contain farms. This procedure was made essential by the fact that available time was too short to allow a complete field search of the island since small clusters or lines of farms tended to be separated from each other by stretches of bush or rubber (see Map 1, in pocket), making total ground coverage out of the question. The Survey Department of Government kindly undertook the task of tracing flight lines for existing air photos (most flown in 1950) onto 1:25,000 topographic maps, indicating on each such strip the corresponding photo numbers. The writer then scrutinized each individual photo to determine areas containing "possible" farms, and indicated such areas on the topographic map. An attempt was made to estimate the number of farms in each area, symbolizing each with a circle, but high accuracy could not be attained here because of the small size of farms and abundance of trees obscuring farmhouses. Next, the Survey Department photostatted the finished map at twice the scale--1:12,500. This provided a field base map which contained topographic information, though much of it was out of date, and circles representing "possible" farms. The scale of 1:12,500 was decided on, after limited pre-testing, as being the most suitable in relation to area covered daily by a team and the number and size of farms to be mapped in an average area.

The Police Department put a number of Landrovers (without official markings) and drivers (in mufti) at the disposal of the survey; altogether, about fifteen were used. Thus, transportation for this phase of the research posed no problem. The biggest problem was based on the fact that the topographic maps were out of date. Use of air photos in their stead would have been impracticable because of (1) the cost involved, (2) the large area covered by a team during a day which would have required constant positioning on many air photos and consequent loss of time, and (3) the students' lack of the training needed for such an effort. A certain amount of error due to out-of-date land-use information on the topographic sheets, which occasionally resulted in incorrect placing of farms on the map, was allowable in this survey; checking rectified some errors, and some work felt to be very inaccurate was discarded.

Field work proceeded in a series of steps, each covering a portion of the island. Within each major area, teams were assigned mutually exclusive areas, each of which included work for an average of two or three days. Each such area was delimited on the basis of practically useful criteria--a main road, a divide, a river--which could be located easily. Each area, or survey "Zone," received a number; within it, farms were numbered consecutively, starting with one. Thus, a given farm was identified by both a zone number and farm number, this double designation eliminating possibilities of giving any two Singapore farms the same identification, and eliminating the need of assigning blocks of numbers to each team.

Punch-Card and Area Analysis.--Data were transferred in a series of operations from the field schedules to Powers-Samas 65-column punch cards. These operations, carried out for the most part by personnel of Government (Office of the Registrar of Malayan Statistics), included the following: (1) coding of the schedules, with each possible answer to each question assigned a numerical or letter code suitable for punch cards of the sort used; and (2) punching of the code values on appropriate columns of the cards. A map was prepared by the writer after his departure from Singapore, during his subsequent tour of military duty, showing the position and number of each farm in each zone, and the location of "possible" farms -- those identified on air photos, and those surveyed but, through loss, defacement, or inaccuracy of the field map, not mapped.

Thus the data for each surveyed farm were made available in two forms: on a map showing its position and identification number (zone number and farm number); and on a corresponding punch card. This state of affairs was eminently suited to statistical manipulation of the data, since complex operations could be carried out simply and rapidly on sorting and tabulating machines. Unfortunately, punching was not completed until some time after the writer's departure from Singapore, other priorities intervened, and machine tabulation had not been carried out in Singapore up to the time of writing.[1]

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[1]Lack of identity between the Powers-Samas and IBM cards made it impossible to prepare duplicate cards on IBM for analysis by the writer himself in the United States.

Since, however, the number of leaf-stem vegetable farms amounted to only a small part of the total, hand tabulation was sufficient for the needs of the present paper. This was undertaken from a printed tabulation sheet of all cards, kindly supplied by the Registrar of Statistics.

Reliability and Completeness.--The total number of leaf-stem vegetable farms in Singapore is estimated to be about 600, the figure having been arrived at by (1) counting the number of "possible" farms in unsurveyed areas, (2) applying a correction factor to this value based on the ratio of actual farms to pre-determined "possible" farms, in areas actually surveyed, and (3) adding the resulting figure to the number of surveyed farms. Five-hundred and two farms, five-sixths of the total, were surveyed. Thus the reconnaissance farm census fell short of completeness, and all island-wide generalizations and averages in the present paper refer, except where otherwise stated, to the total number of surveyed farms, rather than to any assumed total figure for the island as a whole, as the population.

Reliability is also well below an optimum which might have been achieved if the census had operated under more favorable conditions of time and finance. However, checking of sample areas, scrutiny of each schedule for internal consistency and conformance with probable field conditions in an area, and training of interviewers, all combined to provide a standard of reliability sufficiently high for the purposes of the study.

The reconnaissance survey figures in the present dissertation only indirectly. Its use here is limited to the problem of defining various aspects of the leaf-stem vegetable farming system, and thus placing the Kallang farms in perspective.

CHAPTER VII

METHODS, CONTINUED: THE CASE STUDY

Selection of the Farm.--At the end of the micro-regional survey it became clear that further intensity was needed for certain sorts of data, particularly non-quantitative process data. While the reconnaissance census was being planned, it being an attempt to obtain greater extensity, or generality, initial field work began on a parallel project designed to achieve greater intensity for a single moderately typical farm. The rationale for such an effort is discussed more fully by the writer elsewhere (Blaut 1953, 1954b); here it can be summed up very briefly as an attempt to deal more intensively with the productive processes -- valuative, behavioral, and crop-ecological -- which had been discerned in outline in the micro-regional survey and to examine their modes of functioning and inter-relations on one farm. Clearly, the data obtained on this farm could have value only in a non-quantitative, or at best an order-of-magnitude sense, since one farm is representative only of itself. But the highly detailed study of one such farm, a typical one at least to the extent that it is a fair example of one of the important farming systems, served two very definite purposes: It produced certain data which could not have been obtained in even the most intensive phase of the micro-regional survey, the repeated visits to selected farms; and it suggested hypotheses concerning process transactions, some of which could be checked by reference to the micro-regional survey data, or the reconnaissance survey, or both.

Selection of the case-study farm proceeded in the following manner: (1) The "purest" of the leaf-stem vegetable systems, that which involved no significant income from enterprises other than leaf-stem vegetables, was chosen as the system from which the case study would be taken. The Lower Kallang Plain represented the greatest concentration of farms of this type, so the farm was selected from this region. (2) The question of reliability of responses and willingness of the farmer to supply information was adjudged the most important criterion for selection. This suggested that the case study should be chosen from the group of selected farms dealt with in the micro-regional survey. (3) Among the twelve selected farms which three months of repeated interviewing had shown to be most productive of reliable data, the choice was among eight which were "pure," i.e., specialized, leaf-stem-vegetable producers. (4) The final selection was made on the basis of the interviewers' decision as to who among the eight farmers was most likely to provide reliable and complete information. As it developed, our choice of Ng Hong proved to be a wise one; he was most helpful in the work, and his farm was functionally similar to the norm for the Lower Kallang area, though somewhat larger in area than average.

About thirty-five man-hours, in fifteen visits, were devoted to this farm. Results of the study were subsequently published in the Malayan Journal of Tropical Geography (cf. Blaut 1953).

PART II: THE CONTEMPORARY FRAMEWORK OF SINGAPORE AGRICULTURE

CHAPTER VIII

THE CULTURAL ENVIRONMENT

Cultural Landscapes of Singapore Island.--The word "Singapore" calls up, in the popular mind, a bustling, cosmopolitan port city, a nodal point in international trade, and perhaps also a not-quite-impregnable fortress site. From the standpoint of the world at large these functions, plus others associated with Singapore's activity as an outlet and processing center for Malayan products, adequately sum up the city and colony. But in an island of 224 square miles with a population density of nearly 5,000 per square mile, at least 95 per cent of whose 1.1 million people either live in the urban area or depend on urban functions for a livelihood, one other function, that of food supply, clearly becomes critical. In this dissertation we shall consider one aspect of the problem of food supplies for Singapore: local production of the single most highly perishable class of foods, leaf and stem vegetables.

Dobby (1940:84) aptly describes Singapore Island as being shaped "like a bat with wings outspread latitudinally." The island measures twenty-six miles from its eastern to its western tip and fourteen miles from north to south. The city and port occupy the south-central portion, with fingers of urban settlement stretching north to the center of the island and east part way to the eastern tip. At widely separated points throughout the island lie various military airfields, the city's international civil airport, and a naval base. Each has a small urbanized zone within or near it. In addition to these non-rural landscape types, occupying perhaps one-third of the total island area, there are forest reserves and nature reserves (including the municipal watershed reserve taking up a large part of the island's center); a coastline "indented by broad estuaries tending to become mangrove swamps" (Dobby loc.cit.) and forming rather extensive coastal marshes and inland alluvial swamps in places; and, finally, the genuinely "rural" area of occupance, which covers no more than one-third of the island's surface.[1] Map 1 (in pocket) gives a general picture of the areal pattern formed by some of these land-use classes.

Excluding coastal and estuarine wetlands and the forest and nature reserves, the rural portion of Singapore Island includes three major and several minor landscape types. The major types are: land devoted to export crops (primarily

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[1]The following breakdown of areas for the island is given in the 1953 Singapore Annual Report (Singapore 1953:68): urban and transportation 54 square miles; agricultural land (including both smallholder and plantation agriculture) 57 square miles; "Unused but potentially productive" land -- i.e., secondary bush, lalang grassland, etc. -- 49 square miles; forest and woodland 15 square miles; marsh and swamp 18 square miles; "inland waters" five square miles; "airfields...parks," etc. 26 square miles. The breakdown as among urban, agricultural, and "unused" land is to be treated as a very rough approximation.

plantations in the usual sense of the word), small vegetable and mixed farms, and wasteland. Among the minor types two deserve mention: the network of paved roads which, with associated graded roads and tracks, provides access to most of the interior; and occasional very small villages, usually of the <u>strassendorf</u> type, consisting largely of shops and "shophouses" strung out for short distances along main roads.

In 1940 more than half the island's area was under cultivation. Export crops accounted for 80 per cent of the cultivated acreage, with rubber alone occupying over two-thirds of the total. During the Japanese occupation the area under rubber alone fell drastically; cutting out of trees for firewood and food gardens, and general neglect of the plantations were responsible. By 1950 the acreage under rubber had fallen from 52 thousand to 20 thousand, largely accounting for the drop in total area under cultivation in Singapore from 119 square miles in 1940 to 66 square miles in 1950, or roughly 30 per cent of the island's area.[2] In the latter year rubber, coconuts, and minor plantation crops still accounted for two-thirds of the cultivated acreage. But much rubber land had reached a stage of neglect--now due to disinterest in replanting and soil maintenance related to the fact that speculators were holding much of the land for possible sale as urban lots rather than for production--such

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[2]Figures are taken from Singapore Department of Agriculture 1950:22.

that tapping was either desultory or abandoned. In sum, it may be said that rubber had lost its hold on Singapore agriculture by 1953. In that year it could be stated that "although the acreage under rubber is relatively high the yield is insignificant" (Singapore Annual Report 1953:70)--this in spite of the important boom in rubber which occurred during the Korean War.

The decline in rubber was accompanied by a phenomenal increase in land classifiable as waste. The spasmodic fluctuations in Singapore's export-crop agriculture have periodically resulted in such an increase in wasteland, with lalang grass (Imperata cylindrica) generally replacing cultivation on badly eroded land and blukar (secondary bush), a favorable sign of returning forest, appearing elsewhere. This pattern will be discussed in Chapter XI; here we need merely point out that such wasteland occupied more area in 1953 than all crops put together. The pattern of rural service villages, each consisting of a handful of shops strung along a portion of road, has not been indicated in the island map (Map 1). These slightly urbanized areas are, however, significant and widespread. Each functions as a source of most supplies used on small farms, and

[3]"Villages show a uniform pattern: half a dozen Chinese shops are strung along a road...The houses served by the shops are widely scattered...The term 'village' is scarcely appropriate, since the shop group does not constitute a social center and has no unity." (Dobby 1940: 103.)

usually also as a collecting point for vegetables and other farm produce. The roads themselves form a remarkably complete network over the island, one which Map 1 (on which only important, paved roads can be shown) merely suggests. In addition to those roads shown, a dendritic network spreads out from them into plantations, clusters of small-holdings, fishing villages along the coast, and the like. Few if any farms are more than an hour's walk from a road of one or another sort.

Acreage under food crops -- almost entirely vegetables and fruits -- has never been significant. In 1940 it totalled about eight square miles by very rough estimate; during the war it increased drastically, because food shortages favored farming as an occupation, and also forced many (most?) families to stake out their own provision gardens; and in 1950, by the same rough estimate, it stood at about twelve square miles, a growth not out of proportion to that of the total population of the island.

Perhaps the most striking pattern revealed by Map 1 is the curious configuration of small vegetable and mixed farms. Individual farms, it will be noted, are frequently isolated from one another, the intervening land being, in most cases, either plantation rubber or waste. In many areas linear patterns emerge. These usually indicate a single or double line of farms along streams or along the edges of the numerous narrow floodplains fingering into the island's interior. Where solid clusters of farms are shown, these are usually associated with either (1) groups of small hills, small enough so that farms can include all land from the adjoining stream or floodplain-edge to the hilltop, and thus to the farms rising from the other side of the hill; or (2) floodplains with exceptional soil-drainage conditions, such that intensive floodplain agriculture, typically of the leaf-stem vegetable farming types, is feasible.

Thus the over-all pattern of rural land use on Singapore's surface of low, undulating, hills and interdigitating streams and floodplains can be summed up fairly simply. Plantation rubber land and previously cultivated wasteland tend to occupy the better-drained surfaces, although spilling over into floodplains in some areas. Small food-crop and mixed farms form a somewhat more complex pattern. Most farms are directly accessible to a stream or floodplain, to supply water for permanent ponds, for adequate soil moisture on the lower fields; probably also because rural tracks often tend to follow the edges of narrow valleys and floodplains; and, finally, because plantations frequently lease out their poorest land to small farmers, and this is most often poorly drained land. However, many farms occur on uplands exclusively, and create entirely artificial ponds with cement lining to satisfy their farm water-supply needs.

Our concern in this paper is largely with the production of leaf and stem vegetables, so additional analysis of landscapes associated with these types of farms will be given at various places throughout the paper. Discussion of the city of Singapore itself will be embedded in subsequent functional analyses of marketing and supply patterns, and in the discussion of urban demand given in the following section.

The Multicultural Setting.--Some 800-thousand people live in the city of Singapore and another 320-thousand in the rural portion of the island and nearby small islets. Of this total population of 1.1 million, 76 per cent are Chinese.[4] The colony is a British possession, and lies in a Malaysian culture area, but its flavor is distinctly Chinese.

The Chinese population is drawn from a broad zone on and near the southeastern coast of China, almost entirely within the provinces of Kwangtung and Fukien. These two provinces, however, contain a number of quite different dialect groups, and most of these are represented in Singapore. Hokkien-speakers, from the Amoy area of southwestern Fukien, number 341-thousand in Singapore. Teochiu-speakers, from Swatow and adjoining portions of Kwangtung near the Fukien border, number 185-thousand. As will be seen shortly, these two subcultural groups, speaking dialects said to be mutually intelligible, or at least partly so, tend to favor similar farming practices in Singapore, and will be treated as a unit for certain purposes in the present study. Speakers of Cantonese and related dialects -- quite different from

[4]Population figures are taken from the Singapore Annual Report, 1953 (Singapore 1953).

the foregoing -- are from the larger part of Kwangtung, most notably the Pearl River (Si-Pei) Delta around Canton, and number 186-thousand in Singapore. Hainanese, from Hainan Island in southwestern Kwangtung, number 62-thousand; Hakka- or Kheh-speakers, from interior South China and Swatow, number 47-thousand; and other Chinese dialects are spoken by 39-thousand Singaporeans.

Thus 712-thousand of the island's 860-thousand Chinese belong to two major dialect groups, from two separate coastal areas of South China: Hokkiens and Teochius from the Kwangtung-Fukien border area, and Cantonese from parts of Kwangtung farther west. The former number 526-thousand as against 186-thousand for the latter. The latter, however, form the bulk of leaf-stem vegetable farmers, and are of most direct concern to us here.

It would be beyond the scope of this dissertation to discuss the many significant differences in attitudes, occupations, and customs among the Chinese subcultural groups, but certain of these differences are related to the island's farming, and deserve mention. (Unfortunately, no detailed study has been made on the subject, and we can merely block in the relevant topics.) Food habits are perhaps most important in this context; each group prefers certain vegetables, and the differences in festival dates produce a differential demand for higher-priced vegetables by different groups at different times. A second important difference is occupation, largely a reflection of the immigration pattern:

Immigrant Cantonese, especially those from a certain district or village, tended to follow others from the same source area into the same occupational spectrum on arrival in Singapore, as did Hokkiens, Teochius, and others. Kongsis, or informal societies whose members came from the same localities, played a major role in this process. Evidence will be presented in Chapter XI to indicate the importance of this factor in the contemporary differentiation of vegetable farming in the island. It appears to be true that differing periods of arrival in Malaysia as between the Hokkiens and Cantonese, and the "inertia" tending to perpetuate their adherence to farming systems similar to those which were of importance at each such period, are of greater consequence in accounting for the present agricultural pattern than is any prior areal differentiation in China itself. And finally, as Hodder (1953) has clearly shown for Singapore's urban area, and the writer's data indicate for the farming areas, there is a further inertial tendency for new arrivals of one subculture to settle near others of the same group, forming distinctive blocks of uniform or subuniform settlement. Thus we have Cantonese areas, Hokkien areas, and others. In the rural district this provides a basis for regionalizing Singapore agriculture on dialect or subcultural criteria. In the urban area the neighborhoods reveal a distinctive pattern of demand relating to the subcultural group or groups dominant in each.

The Economic and Political Setting.--The Chinese character of the city, with its attendant structure of demand for perishable foods, is a significant determinant of Singapore agriculture, and has been such since the Colony was founded. The farming population is composed largely of exurbanite Singapore Chinese and their descendants; the products of the farms are geared to food preferences of the urban Chinese; and the level of demand for perishable Chinese-preferred vegetables, poultry, and pigs renders it improbable that any other farming systems could compete with the existing market-gardening and mixed-farming types. Indeed, the recent process of attrition of export crops in the island seems an almost inevitable one in light of the fact that the urban population is doubling itself every two or three decades. This may be expressed in a different way by stating that, in all probability, no other crop enterprise can compete with the vegetable and pig-fodder crop complex under existing cultural, economic, and political circumstances. If acreage under vegetables and fodder crops were to increase, or if prices realized for vegetables and pigs were to drop, beyond a marginal level, some farms would go out of business. But so long as they continue to produce they will continue to obtain higher per-acre yields, and higher per-acre value of production, than any likely competitor.[5] We shall have occasion to examine this point more closely in subsequent chapters. It might be noted at this point, however, that Singapore Chinese market gardening, and associated perishable-food farming systems, respond to the economic force of urban demand in the city of Singapore in much the same way that such systems do at the edges of cities elsewhere, demonstrating a cross-cultural regularity of pattern.

A further urban-economic effect of farming in the island is the presence of a large labor market, often within easy commuting distance of the farms. This has produced a competitive pull which is responsible, in at least one farming area (the Kallang Plain, which lies at the city's edge), for a serious labor shortage at the present time. We may suppose that this shortage of labor contributes to the high price of vegetables in the island.

Since the island's farms are heavily dependent on certain imported supplies obtainable only in the city, directly or indirectly, the price and availability of these items have a significant effect on production, both in kind and quantity. The most striking instance of this effect is

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[5]Various reasons have been given for the absence of rice from Singapore Island, the usual one being unsuitability of the climate, with its lack of a dry season. But land suited to wet-rice production is also suited to Singapore Chinese leaf-stem vegetable production, and the latter produces several times the value per acre obtainable in the former, and would do so even under conditions of soil and climate ideally suited to rice -- by no means the conditions found in Singapore. It seems likely that socio-economic, rather than climatic, factors explain the absence of rice.

provided by the major fertilizer used on leaf-stem vegetables, which is imported from Sumatra where it is produced as a by-product of shrimp fisheries. Thus its price is, at least in part, an independent variable, and is related to periodic shifts in production within the framework of the existing systems.

As was amply demonstrated during the Japanese occupation, Singapore's relative distance from food-surplus areas can become at times a source of serious food-supply difficulties. This is true also for those perishables not severely restricted in distance, such as pigs and certain vegetables, which are obtained in part from foreign sources (China, Indonesia). Abnormal political conditions even within "British Malaya" on occasion disturbed the equilibrium between imported and domestic perishable food supplies. The most recent and striking instance of this has been the resettlement of Chinese squatters in Johore, the nearest state in the Federation of Malaya. As a consequence of the communist guerrilla war, Chinese smallholders in parts of the Federation were forced from their farms and into planned resettlement areas, the aim being to eliminate the possibility of reinforcement and food supply to the communists from the farmers. (Cf. Dobby 1953.) The result of this action in Johore was a sharp drop in pig and vegetable imports to Singapore and an increase in prices. The proportion of pigs and vegetables produced in the island increased; local pig production, for instance, reached 98 per cent of the total slaughtered in Singapore in

1953. But after resettled farmers had opened up new farms in the assigned areas, imports increased again, producing, in the case of leaf-stem vegetables, a serious drop in prices and forcing some producers out of business after late 1952.

Singapore's sensitivity to the world economic and political climate, and particularly to that of Southeast Asia, produces cyclic fluctuations in employment, prosperity, and price levels of imported supply items and domestic foods. Thus the island's agriculture, almost entirely commercialized and therefore sensitive in its own turn to the economic pulse of the Colony as a whole, is almost constantly changing in response to changing economic conditions, and has been in this condition of flux since the first decade of the Colony's existence.

CHAPTER IX

"NATURAL" RESOURCES

Landforms and Hydrography.--Length of day may very possibly be the only truly "natural" -- that is, unmodified -- resource factor affecting Singapore leaf-stem vegetable farming. In all other cases, it appears, one or another cultural element intervenes to modify the operation of physical-environmental processes on crop growth or other phases of agriculture. This holds as well for rainfall and slope as it does for soil and vegetation. To emphasize this qualification in the concept of a physical base, the term "natural" must be placed in quotes.

As of 1953, no soil survey of the island had been undertaken, and its geology had been explored only in preliminary fashion.[1] Climatic records have been kept since the last century; though these refer for the most part to the city area, the island is neither large enough nor sufficiently differentiated in elevation to render the records clearly unrepresentative. Botanical studies, though extensive, have not as yet provided anything like a clear picture of plant

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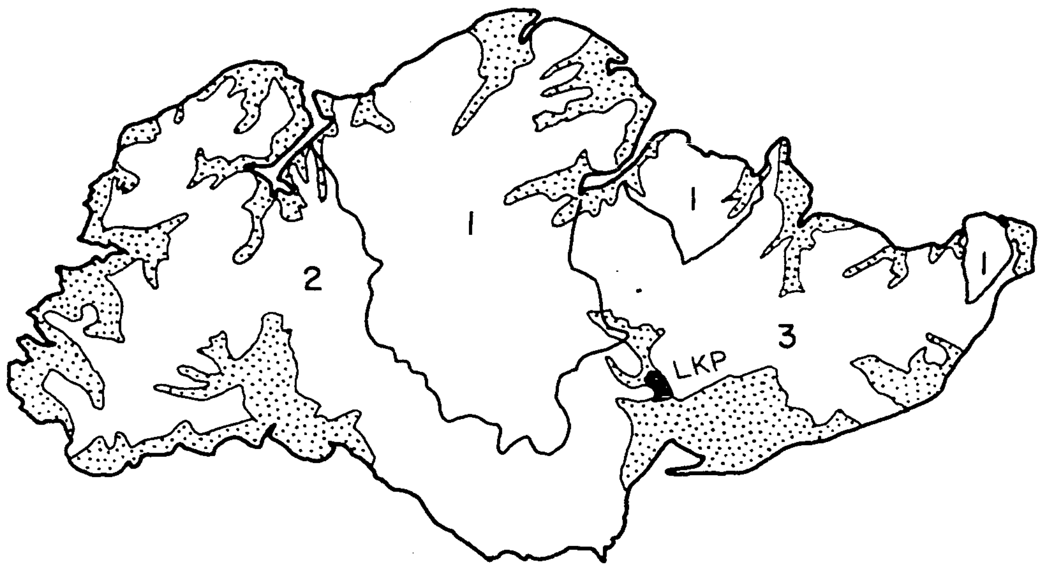
[1]A brief monograph by Alexander (1950) provides excellent qualitative interpretation of the geology of Singapore, but is based only on reconnaissance work by herself, Scrivenor, and others. Thus the map provided cannot serve as a basis for soil regionalization.

successions following human intervention, the condition prevailing over essentially all the dryland portions of the island, although recent work by Holttum (1954) has advanced our knowledge considerably. In sum, it may be stated that the physical geography of the island is not well known, and we shall be forced in the present paper to be highly general in our description of it.

Singapore island is underlain by four separate (though not always distinguishable) classes of rock material. (See Map 2.) (Cf. Alexander, op. cit.:11-21.) The central area, stretching north from the northern part of the city to Johore Strait and across the central one-third of the east-west dimension of the island, consists of igneous rocks, primarily granite. This relatively resistant material provides the highest elevations on the island, including Bukit Timah (581 feet); however, over half of the granitic area lies below 100 feet. Outliers are found at the eastern tip (Changi) and an islet nearby, and igneous dykes occur at places elsewhere. The rock typically weathers into a mass, reddish on well-drained sites, consisting of particles of sand embedded in fines, with the clay content moderately high. Weathering of the granite has been shown to proceed to depths as high as one hundred feet, providing, in places, soils of remarkable depth, and rendering geological investigation peculiarly difficult.

The western third of the island, and most of the city area, are underlain by what Alexander terms "the older sedimentary rocks." Shales and sandstones are the typical rocks of this area. The NW-SE strike of the beds is mirrored in places by ridges or lines of hills which reach elevations of over 200 feet; in most portions, however, the surface is low and undulating and slopes are gentle slopeland. Soils tend, on the average, to be somewhat clayey, occasionally



Map 2. Geology of Singapore Island. 1- Granite; 2- Older Sedimentary Rocks; 3- Older Alluvium; LKP- Lower Kallang Plain. Stippled areas are recent alluvium. (Source: Alexander 1950.)

becoming a stiff kaolinitic clay derived from heavily leached shales.

Most of the island's eastern third is underlain by the third group described by Alexander, the "older alluvium," consisting of "an ill-assorted mass of semi-consolidated sands, gravels and pebble beds with seams and patches of clay" (Alexander, op. cit.:18). These apparently estuarine deposits of uncertain age were probably laid down when sea level was up to 100 or more feet above its present position; they provide elevations up to about this point and extend below present sea level. In a portion of the central part of the older alluvium, hill crests are subuniform in elevation, sometimes forming long, sinuous ridges rising to about the 100-foot contour. Slopes tend to be high in this inner portion, and generally higher than the island's average throughout those parts of the older alluvium having moderate elevation. Soils derived from this material have, on the whole, a higher-than-average content of sand, though rarely are they lighter than sandy loams except on the occasional old beach deposits.

The fourth and, for our purposes, most significant of the types is recent alluvium. According to Alexander, this includes "gravels, sands and clays laid down by the rivers of the present drainage system and the black clays laid down in the swamps related to this system" (20).

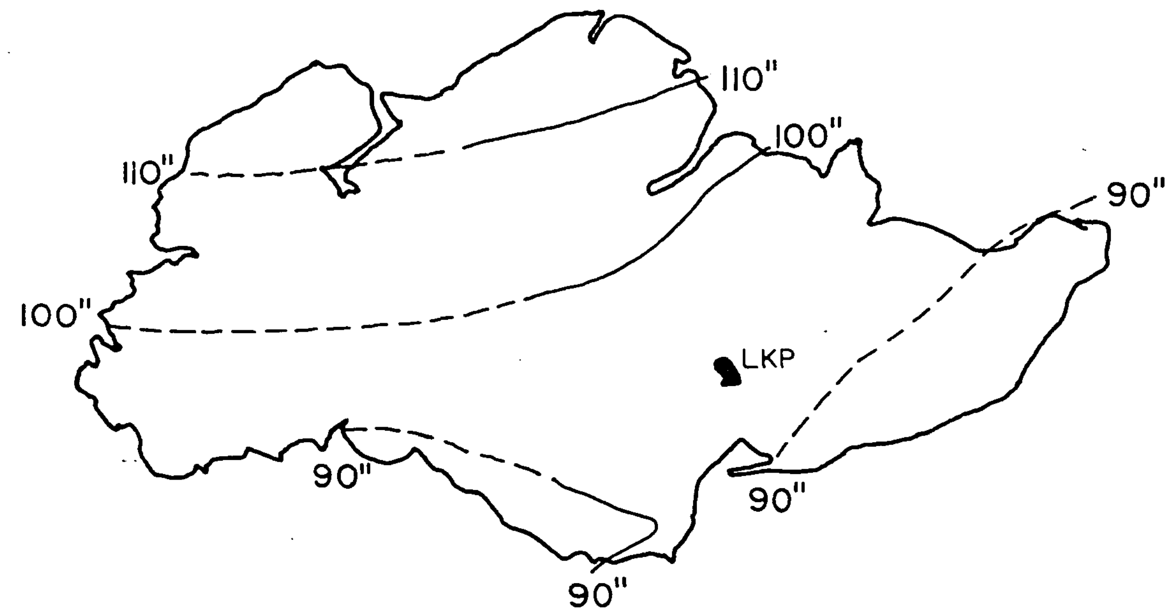
Thus Singapore's essential physical character is that of a partly drowned mass of low hills, these in turn being the remnants of ancient (possibly Paleozoic) mountains. Between groups of hills, as in the northwestern, north-central, and southwestern parts of the island, (along Sungei Kranji, Sungei Seletar, and Sungei Jurong, respectively) tidal estuaries penetrate up to four miles into the interior, and extend themselves even farther as salt or brackish marshes. Each such estuary forms part of a broad, though variable, zone of recent alluvium, which continues on into the smaller valley. Most of this material is derived from subaerial erosion of the emergent hills, and forms alluvial tracts ranging in content from clays to clay loams and sandy clays. Most of the clays in all probability are locally derived, some consisting of material deposited in the broadened estuaries of a previous, higher, sea level stage, some consisting of material washed down into the valley bottoms, and some representing truly marine deposits. Of the latter the most important tract underlies most of the eastern half of the city, and probably extends north into the Lower Kallang Plain. As Alexander notes, "the utilization of every flat piece of land for cultivation or building has obliterated almost all traces" of the marine deposits in this area. (Alexander _op_. _cit_.:21). Fortunately, however, we have a description written in 1849 which clearly indicates the marine, or at least littoral, character of these deposits. According to this writer, the alluvial plain in this area consisted of sandy ridges four to nine feet above sea level -- clearly beach ridges -- between which lay parallel "broad bands of clay soils," with this "blue mud" or, sometimes, "red tenacious clay" extending back to the uplands (Thomson 1849:619-620). Most of the recent alluvium is of a sandier character than that of the Lower Kallang Plain and the city, and represents valley deposits derived from the sandstones and granite, sometimes deep, though often merely covering an underlying layer of clay.

In conformity to the fragmented upland topography of the island, and as a result of the maturity of the surface and high rainfall, the drainage pattern is complex and well developed. Tiny streams can be found in most upland valleys; these soon broaden into sizeable ones, with floodplains; and these, in turn, coalesce into the larger rivers, with their broad alluvial plains, which ultimately flow into the estuaries or directly into the sea. Very probably these streams are broadening the alluvial surface and increasing its sand content at a rate previously unsurpassed, since most of the island's vegetation cover has been either removed or much thinned in the past century.

Climate.--Singapore is one of the few places in the world where annual averages can serve conveniently to illustrate average conditions on most days (or at least weeks) of the year. Average daily temperature is, to all intents and purposes, uniform throughout the year. Rainfall varies significantly, but no truly "dry" season occurs. Winds, too, though variable in speed, are not strikingly so, and the fact that they execute nearly a 180-degree shift seasonally has little direct agricultural importance on a low island of this sort. Relative humidity shows no significant variation from month to month.

Mean annual precipitation varies from below 90 inches in the southeastern portion of the island to about 115 inches in the north-central area bordering the Straits of Johore. Isohyets, tentatively positioned by Watts (1955:24), generally run in an ENE-WSW direction. (See Map 3.) Thus, as a general rule, the northern and northwestern half of the island has 100-115 inches; the southern and southeastern half, 85-100 inches.[1]

Monthly averages for the city (Kallang Aerodrome) range from a low of 6.6 inches (February) to a high of 10.6 inches (December). (See Fig. 1.)



Map 3. Rainfall of Singapore Island. LKP- Lower Kallang Plain. (Modified from Watts 1955.)

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[1]Precipitation figures are taken from: (1) Watts (1955); (2) one set of 1952 daily records from a station near the Kallang Plain obtained directly from the Malayan Meteorological station and adjusted for rain gauge readings in the Plain itself obtained by the writer's assistants during the latter part of that year; and (3) Malayan Meteorological Service Summary of Observation for 1950 and 1951, referring to Kallang Aerodrome. This station is essentially coastal, and lies some three miles south of the Lower Kallang Plain and one mile northeast of the center of the city. Records used are for periods of observation longer than twenty years; these, however, include observations from nearby points prior to the establishment of the airfield, and thus include a possible source of slight error.

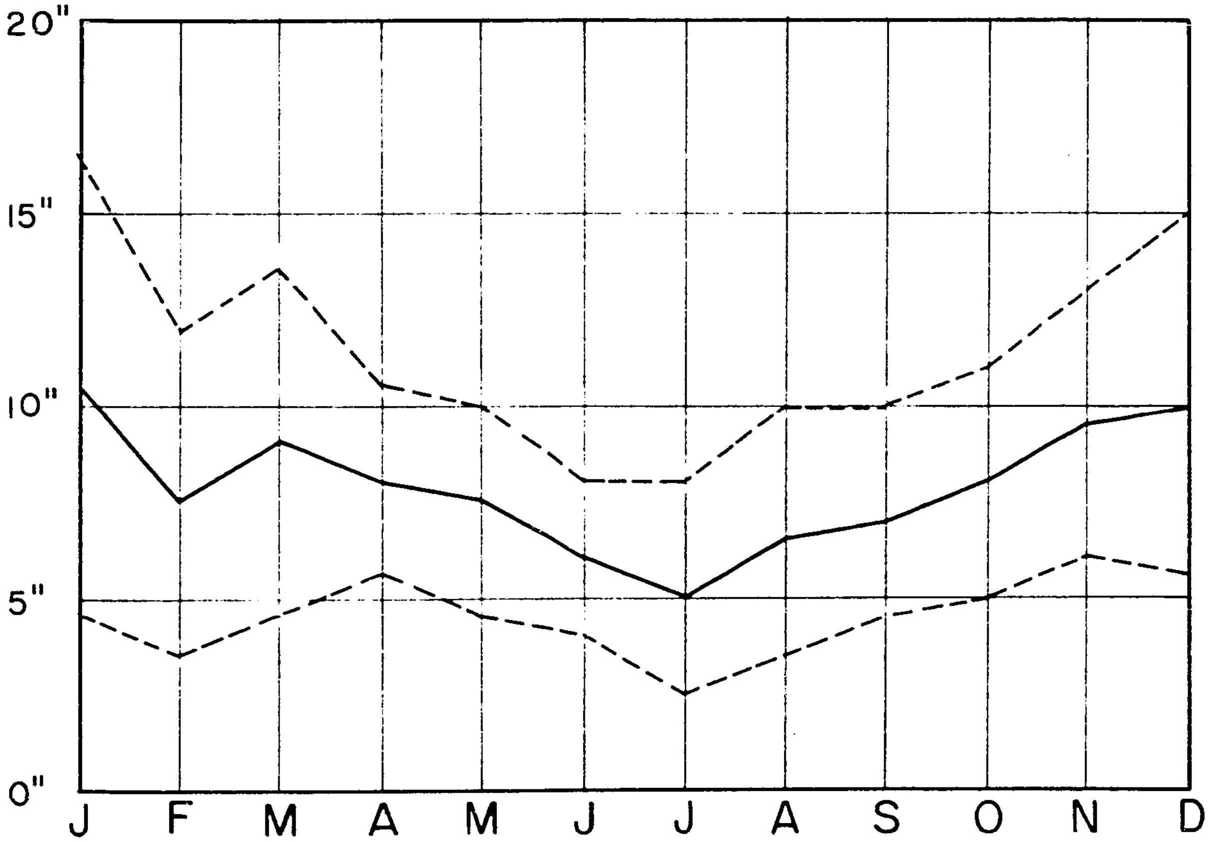

Fig. 1. Mean and Standard Deviation of Monthly Rainfall, Woodleigh Reservoir. This station adjoins the Lower Kallang Plain. (Source: Watts 1955.)

Nine of the twelve months lie in the 1.5-inch range between 6.6 and 8.1 inches. Since 6.6 inches fall well within the category of "wet" months according to Mohr's criterion, based on a 4-inch monthly value for definite excess of precipitation over evaporation in equatorial areas (Mohr 1954:36), the island clearly has no dry or even subhumid season; it possesses a "continuously wet" rainfall regime. As Dobby (1940:92) notes, variations from the monthly mean are rather high: A station adjoining the Lower Kallang Plain with a monthly mean of 7.9 inches records a mean of standard deviations from this value of 3.5 inches. However, for this station, in only four months (February, June, July and August) is the probability as high as (very roughly) one in six (i.e., one year out of six) that rainfall will amount to less than the critical 4-inch value during the particular month. (See Fig. 1.) Rain in excess of .01 inch falls on 184 days in the year, on the average. Daily readings obtained from the station adjoining the Lower Kallang Plain in 1952 showed six rainless periods of seven days or more, though the longest "drought" lasted sixteen days.

Relative humidity averages in the neighborhood of 81 per cent for the year, on the basis of three daily observations (9:00 AM, 3:00 PM and 9:00 PM). Cloudiness is high throughout the year. Observations for 9:00 AM give an annual average of 6.8 tenths and a minimum (in February) of 6.2 tenths, with nine months having values above 6.5 tenths. Three PM readings, as might be expected, give an even higher mean of 7.2 tenths.

The common early-morning fogs are a further factor inhibiting total sunshine.

Although Singapore receives the northern hemisphere Trades for five months and the southern Trades for another five, wind speeds are low, probably averaging below four miles per hour at Kallang Aerodrome and less inland. This is an important factor in accounting for the high relative humidity values.

Finally, temperature is thoroughly typical of an oceanic equatorial site. Mean daily maxima vary from a high of 87 degrees F. to a low of 85 degrees. Mean daily minima vary between 77 degrees and 73 degrees. July, with a daily mean of 81.3 degrees, is the warmest month; January, with 77.6 degrees, the coldest. The difference relates to a high daily minimum in the former month and a low daily minimum (associated with high precipitation) in the latter. The mean daily range is about 12 degrees. Since these values are for a near-coastal station, the averages for the island as a whole probably show a slightly higher daily mean, as well as a greater range.

Vegetation.--It will be shown in Chapter XI that Singapore has gone through two cycles of land-use, each involving a stripping away of most of the pre-existing feral vegetation. Today, with the exception of some coastal wetlands with mangrove, and probably one or two square miles of inaccessible and reserved forest on Bukit Timah hill in the Municipal Watershed Reserve, essentially none of the original natural vegetation remains.

In 1819, when Raffles arrived, the island was densely forested. A few marginal clearings had been made, and a savanna area at the original site of British settlement probably represented the effect of earlier settlement. (The island had previously been occupied by small numbers of Malays.) The coastal and estuarine wetlands sustained mangrove in most areas, as they do today, and some natural savanna of the "wet-and-dry" variety may have been present in sandier wetland locations.

Several distinct types of feral vegetation occur on dryland areas of the island. These can be grouped into three classes forming a highly generalized succession of ecotones from bare soil to secondary forest.

Lalang (Imperata cylindrica and other species), a tough, hardy and burn-resistant tall grass which has been termed officially (i.e. in the Singapore Annual Report, 1952, p.318) "that universal pest," "establishes itself very rapidly and very thoroughly in any open abandoned space." Soil depletion alone possibly does not selectively encourage it, but erosion and burning do: The lalang seems to be the first influent on an eroded hillside and, once established, can succeed in preventing for a time the entry of woody species. Its lack of tolerance for shade allows the latter to intrude slowly from the edges, or in favored spots, but burning forces back competitors and thus favors the grass. Lalang is almost certainly merely a temporary dominant, but human activity on the island has provided the grass with exceptionally secure tenure. We shall have occasion to refer to this curious and noxious vegetation type in succeeding chapters.

Blukar (or Belukar), a Malay term for scrub woodland or brush, either follows lalang in succession or, where favorable conditions occur, replaces it. According to Holttum (1954:30), this stage may last more than 20 years, but, barring interference, it will eventually give way to a true secondary woodland. Characteristically, it begins with species of bush (e.g., Sendudok, Melastoma malabathricum) or low trees, which are eventually shaded out by taller-growing trees. The transition between blukar and the third group, secondary forest, is thus indistinct. Very little of the latter can be found except in the Municipal Catchment Area. In addition to the foregoing, the island possesses mangrove and other forms of wetland vegetation, one or more beach successions, and the small area of relatively untouched forest referred to previously.

Soils.--A detailed discussion of the soils of the Lower Kallang Plain, the farming area to which the bulk of attention in this monograph is directed, will be found in Chapter XVII. At this point a few words on some general characteristics of cultivated soils in Singapore will suffice.

As one would expect in a tropical area possessing Singapore's geological and geomorphic character, the soils of the island fall naturally into two groups: those of the slopelands and those of alluvial flats. The principal distinction between the two, from an agricultural standpoint, lies in their water relations. However, a number of other important characteristics co-vary with this one.

The slopeland soils, with the exception of some heavier types found largely in the western portion of the island, are usually well drained in the zone of cultivation, and not liable to serious waterlogging. Some, notably sandier soils of the Older Alluvium, are excessively well drained. One result of this tendency toward poor water-storage capacity and free drainage is their inability in most parts of Singapore to retain impounded water: Ponds, as we shall see, are an important element in the fruit-earth vegetable and mixed farming system of the slopelands, and farmers find it necessary to line the ponds dug in these soils with cement. Poor water retention also serves to eliminate leaf-stem vegetable cultivation from slopeland soils other than the heaviest ones, since the amount of supplemental hand-watering which would be required to satisfy the water needs of these vegetables is prohibitive under prevailing social and economic conditions.

The free drainage and good soil-air relations of slopeland soils in Singapore mirror a rather low index of texture, or "lightness" in most soil types. Soils derived from the granite are intermediate in texture, the characteristic soil type being, perhaps, a sandy clay or sandy clay loam. These have rather deep profiles, are generally red in color, and were not observed to have significant concretionary horizons.

Soils developed over the sandier materials (the Older Alluvium in the east, and sandstone strata in the west) are typically somewhat lighter in texture. Some of the eastern soils were noted to have a rather high silt content. In some, an unexplained tendency toward claypan formation, accompanied by a shift in color toward greys and yellows and a deterioration in drainage, was noted. By contrast, the soils derived from shale formations in the west are heavier, bright red when well drained, and often characterized by a horizon of ironstone concretion.

The soils of alluvial portions of the island are quite different. Most important, they have rather poor aeration and drainage. On the heavier types (clays and silty clays) this is a function of texture; on the lighter ones it usually reflects a high and fluctuating water table. General observation, and soil mapping in two alluvial areas (the Lower and Middle Kallang Plain and portions of the upper Sungei Jurong near Lokyang village), led the writer to the tentative conclusion that regional differences in texture reflect two variables: source materials for the alluvium, and prior incursions of the sea. The lower end of the Kallang floodplain, for example, has the typical blue-grey clays of shallow-water or swamp deposition, rather than the sandier texture which one would expect from material derived subaerially from the granites and older Alluvium of the Kallang source area. (Of course, a considerable degree of sorting in transit can be assumed to have taken place, with the heavier materials carried farther downstream.) From an agricultural standpoint, a distinction between the heavy clay and silty clay soils, on the one hand, and intermediate types on the other, is the important one for Singapore's alluvial soils. The former possess a number of characteristics which make them highly desirable for the Chinese leaf-stem vegetable farmers, in spite of what would, under other cultural circumstances, be considered highly obnoxious features -- stickiness, poor aeration, high water table, etc. (See Chapter XVII.) The lighter alluvial soils, on the other hand, are subject to a fluctuating water table, occasional spells of edaphic drought conditions, and other conditions relating to soil texture making them undesirable for leaf-stem vegetables.

Hardy (n.d.) has observed that "the soils of Malaya have been classified solely on a geological basis so far, because uniformity of climate has precluded the development of more than one zonal group." This is as true for Singapore as it is for the rest of Malaya. A geological classification (or a geomorphic-geological one) is the most useful in Singapore for other reasons as well. Slope and texture appear to be the significant variables for the Chinese farming systems of Singapore; and soil-nutrient status and top-soil development -- little if any topsoil remains on cultivated soils in the island -- seem to matter rather little in a regime of intensive organic fertilization such as is found here.

The outlines of a simple and tentative classification of Singapore's types of cultivated soils might be offered here.

Since it refers to the level of the soil type or association, it can fit in with the broader classifications based on parent materials (i.e., geology). It should be emphasized that the classification is based on general observation, improved on in only a few places (Jalan Tiga Ratus, Lokyang, and the Kallang Plain) by mapping.

Catena I: Sandy materials in the uplands, becoming heavier downslope. Typical slopeside type: sandy loam. Typical alluvial type: sandy clay or clay loam.

Catena II: Intermediate-textured materials in the uplands, becoming heavier downslope. Typical slopeside type: silt loam or sandy clay. Typical alluvial type: silt loam or clay loam.

Catena III: Heavy-textured (silt, sandy clay, and clay) materials on the uplands, becoming heavier downslope. Typical slopeside type: silt loam, sandy clay, or clay loam. Typical alluvial type: silty clay or clay, with gleyed soils prominent.

In addition, the rather heavy alluvial types not derived from adjoining uplands must be mentioned as a non-catenary type. The clays and silty clays of the Lower Kallang Plain -- if our hypothesis regarding their origin is correct -- would be an example of such an association. These soils are marine or swamp derived.

The foregoing classification bears a relation to the two important farming systems of Singapore. The preferred types for fruit-earth vegetable cultivation seem to be slopelands of Catena II; those of Catena I are too light and well drained, while those of Catena III are too difficult to work. Alluvial soils preferred for this farming system seem to be the lightest, such as the sandy clays. The level of the water table, however, seems to be a significant factor overriding type for all but the heaviest alluvial soils farmed in this system; the latter are given a low value.

Milsum and Grist offer the following observation on soil types with reference to vegetable gardening in Malaya as a whole:

> To sum up, it may be asserted that deep loams or alluvial soils, rich in organic matter and moderately light are the most suitable and require the minimum amount of preparation. Sandy and "laterite" soils require heavy and repeated applications of organic manures, but can be converted into good vegetable beds. Clay soils are too heavy, cold, and damp and are as unsuitable as barren sandy soils. The cultivator cannot expect that either very light or very heavy soils, *particularly the latter*, will ever attain the same degree of perfection as a naturally well-balanced alluvial soil (Milsum and Grist 1941:8; italics inserted).

While this statement seems to apply very well on the most general level to Malayan vegetable gardening, which includes highland areas such as Cameron Highlands (where the adjective "cold" for heavy types would seem to have its only applicability), and the non-Chinese farming system as well as those of the Chinese, it does not apply well to one of the two Singapore systems, leaf-stem vegetable cultivation. This system seeks out heavy clays rather than the "happy mean" soil types which Milsum and Grist mention. However, the statement describes reasonably well the soil preferences of fruit-earth vegetable farmers. Its emphasis on soils "rich in organic matter" does not apply for the simple reason that a half century of soil mining, which preceded vegetable cultivation in the interior slopelands, effectively removed the "richness" of the soil. Subsequently, the vegetable farmers evolved a system which does not rebuild the soil's "A" horizon in the slightest degree: It adds great quantities of organic matter -- enough to suggest that original fertility is of little consequence in any case -- but only to emplaced pits in the ridged vegetable beds. With this system, soil erosion poses no serious problem, since the subsoil on farms in most cases is not dissimilar in texture to the hypothetical topsoil.

PART III: EVOLUTION OF THE FARMING SYSTEMS

CHAPTER X

CHINESE AND MALAYSIAN ORIGINS

Introduction: The Historical Problem.--In this chapter and the one which follows an attempt will be made to reconstruct the evolution of Singapore's vegetable farming systems. Basically, three problems in historical process are involved. First, it is important to establish a datum, in space and time, which can be identified as the short-run point of origin for each important system. Since our primary concern is with contemporary patterns in Singapore, it will be sufficient to discover the immediate progenitors, whether these are to be found in China, in Malaya, or in Singapore itself. Second, we shall have to trace patterns of evolution from these earlier systems to the present. And third, since certain critically important features of the contemporary situation cannot be explained synchronically, by functional analysis, their explanation requires tracing the functional fields back to a past situation in which they first appeared, and attempting to explain their appearance at that place and period. The first of these questions forms the subject of the present chapter; the second, of the following one. The third will arise at various points in both chapters. Most answers will, of necessity, be framed in terms of greater or lesser probabilities, since the factual base is meagre.

The Vegetable Farming Systems of Singapore.--Two farming systems will be considered, these being the most important in Singapore today and also, perhaps, keys to others which resemble them.[1] The first (See Maps 5 and 6) is lowland leaf-stem vegetable cultivation, a functional field whose chief identifying characteristics in Singapore are: (1) strong emphasis on fast maturing vegetables rather than root crops, fruiting vegetables, vegetables of any sort used for fodder, or other crops; (2) relative insignificance of pigs and poultry in comparison to the second farming system; (3) use of flat alluvial soil with a heavy texture (clayey) and a high water table; (4) permanent ponds or other sources of water on or adjoining the farm; (5) heavy fertilization with organics; (6) heavy labor input; (7) intensive hand-watering; (8) few if any essential tools other than watering buckets and hoe; (9) accessibility to an urban market which is no more than a few hours effective distance from the farm; (10) small size of farm (usually under one-half acre); (11) almost complete commercialization of production; and (12) a South Chinese, usually Cantonese, cultural background.

The second farming system (See Map 4) is a composite of two or more enterprises. Its functional field has the

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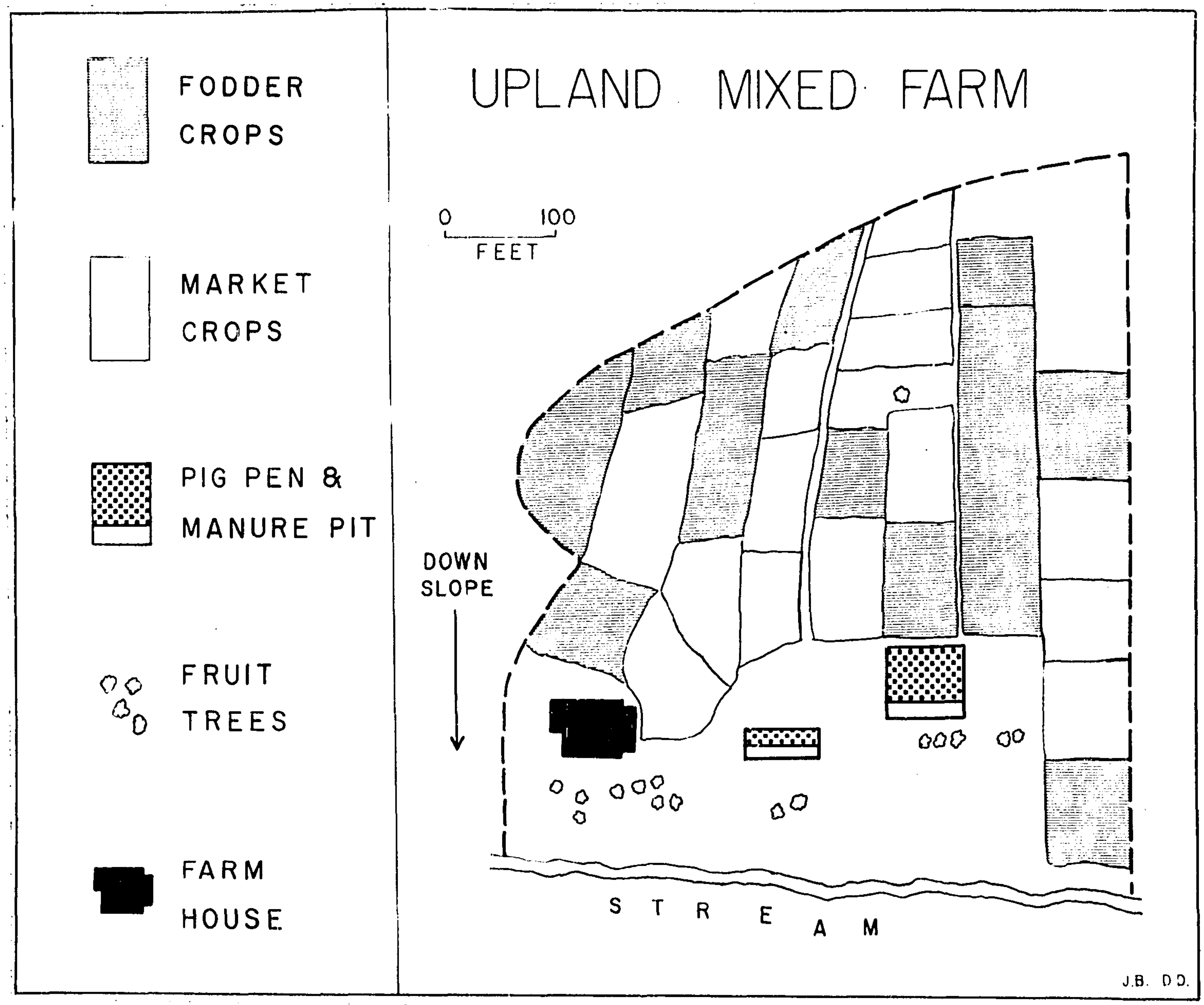
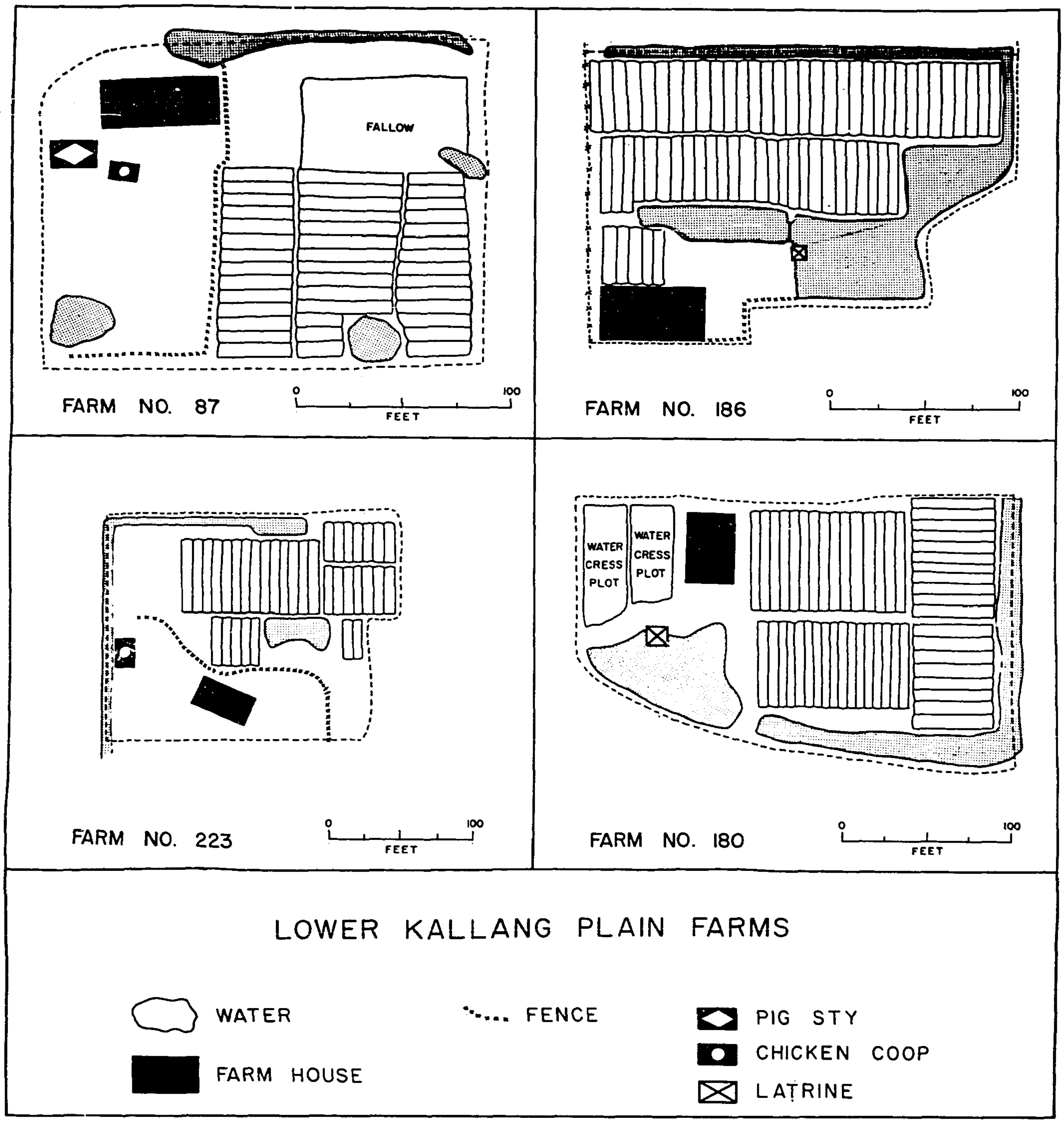
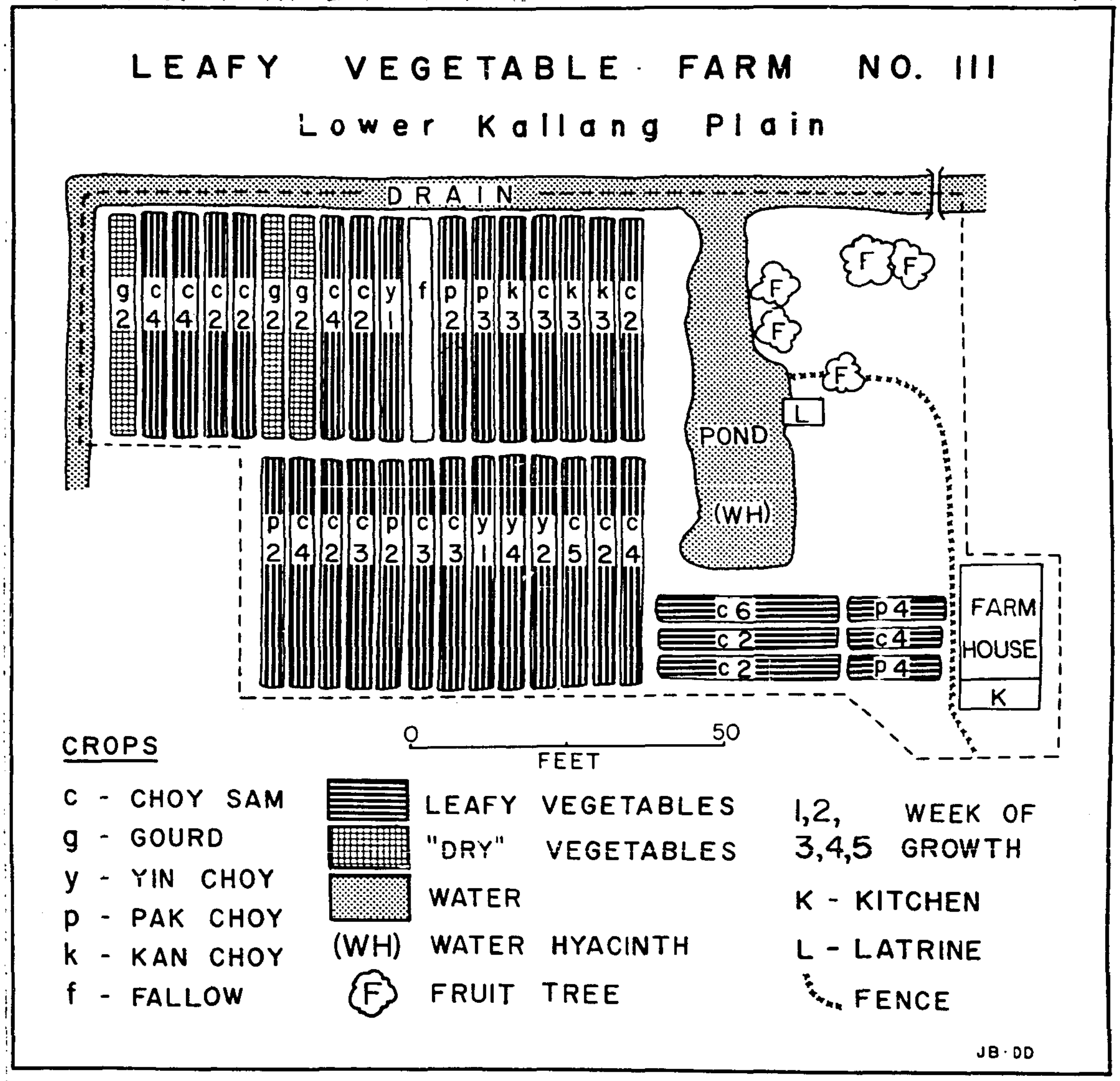
[1]Although the present dissertation deals principally with leaf-stem vegetable farming, it will shortly become clear that the evolution of this system cannot be understood except in relation to that of mixed farming.



Map 4. A mixed pig and fruit-earth vegetable farm (Jalan Tiga Ratus). Note the high proportion of fodder crops, principally sweet potato and tapioca. (Source: field sketch map.)



Map 5. Four specialized leaf-stem vegetable farms of the Lower Kallang Plain. Note the proximity of vegetable beds to ponds. (Source: field sketch maps.)

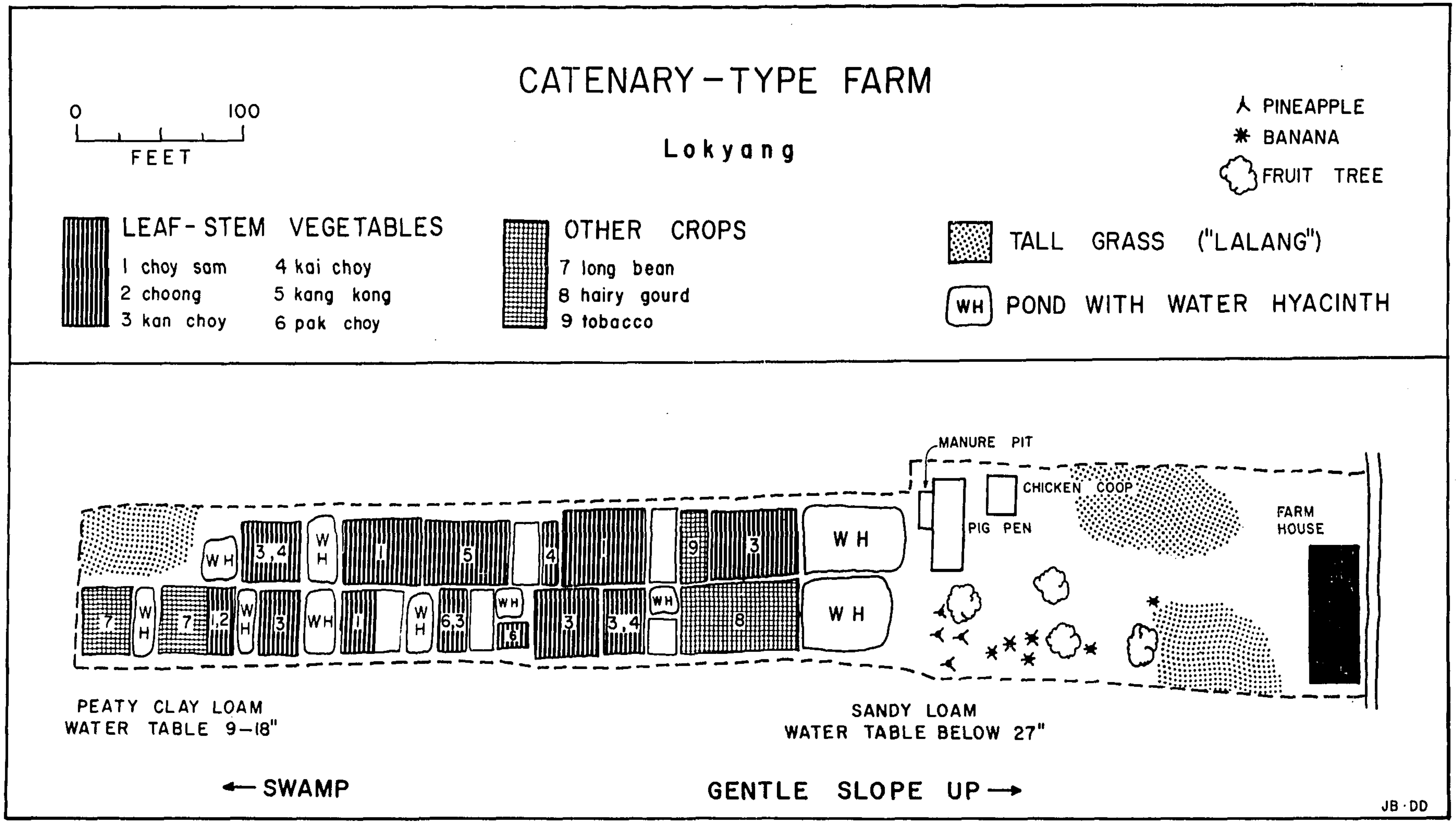


Map 6. Detailed map of a specialized leaf-stem vegetable farm in the Lower Kallang Plain. The fence is a barrier against intruding chickens. (Source: field sketch map.)

following identifying characteristics in Singapore: (1) production of fodder crops and fruit-and-earth vegetable crops, the latter partly for sale; (2) emphasis on pigs (sometimes, also, poultry) as a marketable product; (3) either flat alluvial soil with light texture (sandy) and a relatively low water table, or much more commonly, slopeland soil with intermediate texture (sandy loam, sandy clay loam, sandy clay) and low water table; (4) usually a pond on the farm, either cement lined or self maintaining, or an adjoining channel; (5) relatively large size of farm (typically 2-3 acres), the common areal pattern involving crops ranged on a hillside with the farmhouse, pig sty, and pond (too far from the fields for intensive hand-watering, if, in fact, enough water is available for it) below; (6) high labor input, though less per acre than in the leaf-stem vegetable system; (7) fertilization with pig manure and other farm-produced organics, usually in semi-dissolved form, and placing of fertilizers between the crops in each of the raised and contoured rows of crops; (8) a wide variety of tools, including hoes, ladles for fertilizers, and boiling pots for stock feed; (9) relatively more-tenuous contacts with the urban market, based on longer crop and stock cycles and greater average distance from the market; (10) dependence on purchased stock-feed concentrates; (11) almost complete commercialization; and (12) South Chinese, almost invariably Hokkien or Teochiu, cultural background.

Important variants of the two systems or, depending on one's viewpoint, separate farming systems exist in Singapore, though they are less numerous and important. Essentially all combinations of four separate enterprises can be found, the four being livestock, fruit-earth vegetables (sometimes grown as fodder), leaf-stem vegetables, and fruit trees. An important variant is the "catenary" system, using slopeland and alluvial soils simultaneously, and possessing all four enterprises (See Map 7).

While the ideal to be sought in analysis of the present sort is a tracing of the individual functional field backward in time, recording points where important characteristics were added or subtracted and explaining why such occurred, and finding a reasonably distinct point of origin, such has proved impossible in this case. The analysis will frequently shift its ground from the functional field as a whole to the separate process element or complex of elements, and back again, depending on the quality and kind of data available in a given context. In many cases tentative interpretations will have to be ventured on the basis of wide and often shaky extrapolation from a few reliable facts. One root difficulty is the fact that few of the early accounts of Singapore mentioned vegetable cultivation. Many long discussions of export crops, of the island's rural landscapes other than those of vegetable and pig farming, and of other aspects of early Singapore exist, but these almost invariably overlook the food-crop cultivators, even though the latter were on the outskirts of the town itself. This may be due to the strong mercantilist impulse of 19th-century Singapore, with trade



Map 7. A farm combining features of both the mixed and specialized vegetable farms. Leaf and stem vegetables are located toward the swampy, lower end of the farm. Ponds serve as sources of water for the vegetables and also as substratum for growing water hyacinth, a pig food. The pig and poultry enterprises are located at the drier, sandier end of the farm. Farms of this "catenary" type are found along swamp margins at Lokyang and a few other localities. (Source: field sketch map.)

the prime object of attention, export of island produce a secondary one, and nonbasic economic activities merely unavoidable necessities. Social accounts, also, ignored this group. Granted, of course, the food cultivators were few in number, and their farms never occupied much of the island.

Origin of the Leaf-Stem Vegetable Farming System.--If the essential functional elements in the leaf-stem vegetable farming system, or the functional field as a whole, can be traced to South China at a date preceding the founding of Singapore, in 1819, and if diffusion of the field or its elements to Singapore can be demonstrated, we can assign a South China, pre-1819, origin to the system. However, other possibilities exist: first, that the field evolved principally in Singapore itself; and second, that its origins are to be found elsewhere in Southeast Asia, whence it diffused to the island.

Sir John Barrow, private secretary to Lord McCartney on the latter's embassy to the Emperor of China about 1800, writes as follows: "On the 10th of December we halted before a village which was just within sight of the suburbs of Canton...In the neighborhood of this village are extensive gardens for the supply of the city with vegetables" (Barrow 1804:407). Among the crops he found to be grown there were several sorts of beans, and "large mild radishes, onions, garlick, capsicum or Cayenne pepper, concolvulus batatas, or sweet potatoes, tobacco, ginger, sinapis, or mustard, and the brassica orientalis" (408); in short, both leaf-stem and fruit-earth vegetables, many of them the same varieties grown today in Singapore.

Unfortunately, this unambiguous account cannot be supported by others of the same sort written, like that of Barrow, before Singapore's founding.

If, however, we make the assumption that a farming system described for South China later in the same century, or as late as the first decade of the present century, is likely to have persisted since 1819 or earlier, other evidence can be admitted. A "Description of the City of Canton" appearing in the Chinese Repository in 1834 offers the following: "Southward from the city...rice fields and gardens occupy the low lands" (Lyungstedt 1836:222). The gardens referred to may have been mulberry fields, but most probably were vegetable gardens. Lyungstedt's description of Macao in 1836 includes a reference to the "Campo," an area between the city itself and the isthmus connecting it with the mainland, the lower portions of which "laborious husbandmen render very productive; it bears rice and a great variety of vegetables" (Lyungstedt, op. cit., 32). The time of year is not specified -- an important point, to which we shall return shortly. Reverend David Abeel, also writing in 1836, although his visit to the area probably took place in 1830, gives the following description of Honam Island, which includes the southern suburbs of Canton and the adjoining farming area: "The land is principally low -- partially inundated by the tide waters, and devoted to the cultivation of rice...Where its surface is not too level and saturated, it is arranged in terraces, and planted with a great variety of vegetables, ginger, a species of indigo, etc." (Abeel 1836:99). He, too, provides a list of vegetables, those he found to be sold in Canton: "Pumpkins, melons of various sorts, cucumbers, carrots, asparagus, gourds, squashes, tomatoes, egg-plants, okers, and winter cherries [?]," as well as other unspecified varieties (78). The list includes no leaf-stem vegetables, it will be noticed. The description is for July. A few years later the Rev. George Smith, writing about Amoy, a rocky, granitic, island which boasted a city of some 250,000 in 1847, states that "in the northern and eastern parts of the island a few miles of level sandy soil intervene between the hills and the beach, and yield a supply of rice, wheat, and vegetables" (Smith 1847: 425). The season of observation is not specified. In _The Treaty Ports of China and Japan_, a voluminous geography-cum-guidebook published in 1867, relevant observations are provided for several South Chinese and Formosan cities. Regarding Amoy, the following account, written by an unnamed missionary "many years before," is quoted: "Where water can be procured...the sides of the hills are terraced and made to yield some vegetables to the hand of industry" (Dennys 1867:248). The same work provides another account, quoting another unidentified source:

> The soil of the island is naturally thin and unproductive, except in the small valleys where water is found and where the mould of the higher regions has been collected by mountain torrents. The industry of the Chinese has, however, in some measure overcome the original barrenness of the ground and now secures tolerably good

> crops...chiefly of sweet potatoes, paddy, wheat, sugar cane, ground nuts, and garden vegetables (ibid.:249).

In Chang-Chow, the important inland city of nearly a million (in 1867) for which Amoy is the outport, we are told that the "markets are well supplied" (259), presumably with provisions. Tamsui (now Taipeh), in Formosa, exported pickled vegetables, probably leaf-stem vegetables, to the mainland. Taiwan-Fu (now Tainan), also in Formosa, is described as having market gardens outside the city walls, on a level plain.

For Macao, the Campo (referred to earlier by Lyungstedt),

> ...though in many parts interrupted by rising ground the soil of which is unproductive...is cultivated wherever possible by market gardeners, who grow large quantities of potatoes and European vegetables for the Portuguese, including cabbages and cauliflower during the winter and early spring (ibid.:212).

And finally, returning to Canton, this volume provides several highly relevant observations. The markets of the city are well supplied,

> ...though in summer the range of diet is naturally restricted...In summer, vegetables, such as tomatoes, brinjals, okra, French beans, peas, onions, vegetable-marrow, cucumbers, etc., are plentiful; and during the winter tolerable cabbages and lettuces abound (ibid.:136-137).

Between the Heights of Canton, a hilly zone immediately within the northern wall, and the White Cloud Hills lying northeast of the city, is a winding valley in which were found rice cultivation and "the laborious spade-husbandry of the market-gardener" (179). A village on the deltaic land southwest of the city (in the Nam Hoi district) was to be reached by walking from Canton through "rice fields and vegetable gardens" (198). Excepting only the description of Canton markets, none of the accounts in The Treaty Ports specifies the season of observation; although the descriptions purport to refer to typical conditions, one can assume that some of the cities described were visited by the authors only once, and for a brief period in one or another season.

Hughes, writing in 1872, and Pitcher, in 1909, provide lists of vegetables grown in Amoy, giving further evidence of vegetable cultivation (both leaf-stem and otherwise) for that island and city (Hughes 1872:49; Pitcher 1909:46). (The two crop lists are quoted later in this chapter.) Thomas, in 1903, speaks of "tremendous vegetable fields many acres in extent" near Canton, appending a map which shows these as lying to the east of the city. He adds the observation that "Canton supplies nearly all the vegetables for the Hongkong market" (Thomas 1903:7). He notes further that hillsides along the Si Kiang near the delta edge are covered, in places, with sweet potatoes (36).

Frank H. King, in his penetrating and authoritative work, Farmers of Forty Centuries (1911), provides a long and detailed description of vegetable cultivation near Victoria, Hong Kong, and near Canton. His observations were made in February, but if we ignore for the moment the fact that he was dealing with what was at least in part a seasonal farming enterprise, we can discern in the agricultural system he describes a leaf-stem vegetable farming system not dissimilar to that of Singapore. Leafy vegetables were grown on raised, cambered beds, substantially identical to those employed for such crops in

Singapore (King 1911:88). Gentle slopes were farmed in Hong Kong (Happy Valley), but the fact that surface irrigation was used implies a soil with intermediate or heavy texture. Sam Shui, a flat area immediately east of Canton which, in this season, was an important producer of vegetable crops, possessed rice soils, which are necessarily heavy. Irrigation involved either surface flow (sometimes assisted by pipes) or hand-watering. The latter employed "liquid manure," or water in which organic manure is dissolved. (While Singapore's hand watering employs essentially pure water, it is nevertheless true that very dilute urine and feces are present in it, since latrines are suspended over the farm ponds.) No full list of crop varieties is provided by King, but Herklots' recent work on Hong Kong agriculture (Herklots 1947) gives such a list -- which includes every significant Singapore leaf-stem vegetable. Pond or river mud was used in Canton, as it is in Singapore. Organic fertilizing emphasized night soil in the former, but the substitution of other materials for night soil in Singapore can perhaps be attributed to the Colony's health regulations. The primary tool in the Hong Kong of King's time, as in Singapore today, was the hoe. Production was highly commercialized, in Hong Kong, as it is in Singapore, in the former area farms lying close to Canton and Victoria, and growing provisions for the urban markets. And farmers in Hong Kong were, as we should expect, Cantonese.

Thus we can speak of a farming system in the Pearl River delta area which was (and is) strikingly similar to the leaf-stem vegetable system in Singapore, and we can date this at least as far back as King's visit to South China. The question still remains, however, whether the system existed there early enough in the 19th century to permit us to infer that it was introduced into Singapore during the first few decades following the Colony's founding in 1819. The few accounts quoted suggest that this may be true. Still, further evidence must be marshalled, and for this we have to seek particular references to individual functional elements present in the Singapore system.

Per Osbeck, in his description of the Canton area drawn from a visit in or about 1751, notes the presence there of several of the most important crops which are present today in the Singapore leaf-stem vegetable system. Among these are

> Chinese cabbage...Brassica Chinensis or as the Chinese call it _Kay-lann_...Another sort, which the Chinese call _Pack-so-a_...Among all the cabbages which we brought for our ship I did not see one head but they were all in flower...Celery and spinnage, which is here called _Bout-say_...Convulvulus reptans, by the Chinese called _Or-say_. This creeping convulvulus grows spontaneously every where, in ditches, in low places (Osbeck 1771:309-314).

"Kai lan" is one such Singapore crop; "Pack-so-a" is clearly "pak choy", another; the cabbages "in flower" would most probably be the variety of Brassica chinensis termed "choy sam", another such Singapore crop, which is sold in flower-- and partly for its flower -- in Hong Kong, according to Herklots (_op. cit._); celery, another, is unmistakeable; "spinnage" could be any of a number of Singapore Chinese spinaches. "Or-say" is clearly _Ipomoea reptans_, given the Malay (?) name "kang kong" in

Singapore, where it is an important crop.

Eckeberg, who accompanied Osbeck, appends "An Account of Chinese Husbandry" to Osbeck's report (Eckeberg 1771) in which he lists "sallads...leeks...spinage, celery" as being grown (298-299):

> Instead of cabbage, they used a plant with great coarse leaves...The yellow flowers...were like those of cale. They daily use this plant, and therefore it went off so fast, that they immediately sowed the void beds with it again. It grew very fast in all seasons (301).

Choy sam, the most widespread leaf-stem vegetable crop in Singapore, has a crop cycle of about sixty days if allowed to go to seed, and the description almost certainly refers to this crop.

Exact information on the degree of association or lack of association between pig production and vegetable production in South China of the 18th or 19th century is not available. Eckeberg (1771:287), Davis (1836:386), and Gray (1878:119-193) mention pig manure as one of the fertilizers used on rice and vegetables in the Canton area. Eckeberg's discussion (292-308) implies that pigs were kept by other than farmers, though perhaps by farmers as well. There is a strong probability that the great quantity of ducks kept on farms in the Pearl River delta area (Eckeberg 1771; Winterbotham 1795) contributed to fertilization, the ducks feeding on water vegetables in ponds (cf. Skvortzow 1920), and the pond water being returned to the vegetable beds. The extent to which this may have replaced pig manure is uncertain. Most writers emphasize the use of night soil as a fertilizer, and the use of this substance may have obviated the need for large quantities of pig dung, depending in part on the relative prices of the two. In any event, heavy fertilization with organic materials, ranging from night soil through pig manure to leather and even human hair, was (and still is) characteristic.

The kind of land planted to leaf-stem vegetables varied widely in South China; however, availability of water for either hand or surface application seems to have been a more-or-less universal requirement. The ponds which are universally present on Singapore leaf-stem vegetable farms are frequently replaced in South China by other water sources, such as ditches, irrigation channels, river courses, and the like, but all answer the same need for available water. Credner (1935) describes the use of water sources other than ponds, including those sources mentioned for South China, on Chinese vegetable gardens in the neighborhood of Bangkok. The writer has observed such gardens outside Djakarta, the water source here being for the most part irrigation ditches.

The method of fitting the vegetable bed in Singapore, and the shape, size, and length of the bed, appear to differ from what is found in parts of South China, although King (op. cit.: 88) provides a photograph of cambered vegetable beds near Canton which seem identical with those of Singapore. But functional similarity can be argued, although forms differ: Under differing ecological conditions the same farming system will employ different means of maintaining optimum soil air and moisture conditions. As an example we may note the practise of growing vegetables along broad earth bunds separating flooded rice fields, ponds, and river courses, which is characteristic of Chinese vegetable gardening near Bangkok, where a high water table and considerable flooding are present (cf. Koenig 1779; Credner 1935; Pendleton 1947); in parts of the Pearl River delta (e.g., Nam Hoi) vegetables are similarly grown on bunds separating rice or mulberry fields under the same conditions of poor drainage, where vegetables must be lifted above a high seasonal water table, according to King (1911) and those Singapore farmers who recall Pearl River delta practises.

Where terraced rice fields were given over to winter crops of vegetables in South China, we can speak of functional identity with Singapore farming in land type. A terraced rice field is flat; if devoted to wet rice it must possess moderately heavy soils; and, as indicated above, its use for leaf-stem vegetables in the winter season implies a source of irrigation, though not, of course, flooding. Leaf-stem vegetable fields described by Dennys, King, and others as having been situated to the east, south, and southwest of Canton city would, in most instances, have been making use of deltaic alluvial soils, with a high water table. (The area described by Abeel, however, may have been an alluvial terrace.) On the other hand, there is ample evidence that non-irrigable sloping land was devoted to the production of vegetables, possibly including leaf-stem vegetables where the water source was close, in parts of South China. Among the areas in which slopeland was used for this purpose, we may mention Macao, Hong Kong, Amoy, and Canton. (King [*op. cit.*:68] provides a photograph of such a slopeland vegetable field in Happy Valley, Hong Kong.

Other critical features shared by the early South China farms and those of Singapore include intensive labor input, intensive hand watering or surface irrigation, few essential tools in the production of vegetables, accessibility to an urban market, almost complete commercialization of vegetable production (even, it appears, where the rice crop was partly subsistence oriented), and small size of farm. Various of these features of South Chinese agriculture are discussed in Osbeck, Eckeberg, Barrow, Ljungstedt, Dennys, Gray (1878), King, Shim (1924), Wittfogel (1931), Pereira (1935), Chen (1936), and Hommel (1937). Three of these features, hand watering, the limited number of tools, and the proximity of farms to an urban market, deserve further mention.

Hand watering with the dual buckets and shoulder pole used in Singapore is referred to for South China by Gray (1878:196), King, and Franck (1925:255). King (1911:74) provides a photograph of the apparatus, showing it to resemble that in use in Singapore. While most writers describe other forms of irrigation for vegetables in China, it should be noted that Singapore farmers would themselves prefer to have gravity rather than muscle power convey the water to their beds.

Tools in use in South Chinese agriculture are, of course, diverse and often complex (e.g., certain plows, and water lifts operated by foot power), but vegetable production for the most part employs only simple ones, the hoe predominating. According to King (87-91), other hand implements are used to throw up ridges for winter vegetables in the rice fields, and later to smooth the fields again; the plow is only used afterward, to fit the smoothed field for the first rice crop.

Most of the descriptions we have refer to areas surrounding the major cities -- Canton, Amoy, Hong Kong. From this it might be inferred that vegetable cultivation is strictly of the "market-gardening" variety as envisaged by von Thünen, i.e., taking place close to the market itself. On the other hand, the planting of winter and spring vegetable crops seems to be a widespread practise throughout at least the Pearl River delta area. However, this area includes many cities, none very far from another, and it seems probable that few parts of the delta are sufficiently distant from an urban market to preclude the movement of fresh greens from farm to market in a few hours or overnight. While the population will have been lower in the early 19th century, the pattern of cities was similar, and good accessibility to market (as well as the presence of a set of urban markets) probably prevailed then as now.

It is clear, then, that most of the critical elements in Singapore's Chinese leaf-stem vegetable farming system existed in South China during the 19th century, and probably as early as 1819, the date of Singapore's founding. Furthermore, locating the mechanism by which the system or its elements may have emigrated to Singapore (directly or indirectly) poses no problem. Immigrants to Singapore from most of the important source areas (the Pearl River delta, Macao and coastal southern Kwangtung, Swatow and eastern Kwangtung, Amoy and western Fukien) arrived in a continuous stream during the 19th and early 20th centuries. Most of the farmers interviewed by the writer in Singapore had been, or their forebears had been, farmers in China before emigrating, and we may assume the same to have been true during the last century. (Cf. in this connection Purcell 1951.) Undoubtedly few if any of the migrants had been market gardeners in China, but it is sufficient for our purposes to know that many engaged in the production of leaf-stem vegetables for market as a winter and spring enterprise on rice and mulberry farms.

Next we must briefly consider the alternative hypotheses: (1) that the system originated in Southeast Asia and subsequently moved to Singapore; or (2) that it originated in Singapore itself. As to the first, two problems must be considered: (a) Did the system exist in Southeast Asia before Singapore was founded ? and (b) Was it brought to the island from other areas of Chinese settlement?

De Klerck refers to the existence of Chinese market gardening outside Batavia shortly after its founding in 1619 (de Klerck 1938:260,268). Malacca, the city and territory from which many Chinese emigrated to Singapore in 1819 and the years following, seems not to have possessed a significant Chinese vegetable-farming pattern. Valentyn, writing in 1726, states that "the place is not very productive in provisions; everything must be imported from other places, with the exception of fish and some kinds of fruit" (Valentyn 1884:51). Some vegetables were most probably grown there in Chinese pepper gardens, especially during the first two years on a newly-planted field, but these were hillside fields, on light soils, and very likely bore little resemblance to the Singapore leaf-stem vegetable system of later years. Koenig, writing in 1779, speaks of seeing Chinese vegetable cultivation (type unspecified) on the Chao Phraya lowlands near Bangkok; but the present writer is not aware of significant emigration from Siam to Singapore during the early years.

Penang, however, was "abundantly and daily supplied with...vegetables" in 1797 (Leith 1805:28), and roughly half of its population was Chinese. Penang (then called Prince of Wales Island) and Malacca together accounted for a large number of Chinese immigrants into early Singapore. Thus the possibility of transfer from these areas, particularly the former, to Singapore does exist.

Both hypotheses, that of pre-1819 Southeast Asian origin and that of Singapore origin, must, however, contend with the substantial weight of evidence in support of the hypothesis previously considered: that of Chinese origin. As we have seen, most essential elements in the Singapore leaf-stem vegetable system were present in China at the right time for diffusion to Singapore. Further, the possibility cannot be ignored that the system was introduced into the island by Chinese arriving from other Southeast Asian areas, but bearing an essentially unchanged South Chinese functional field, which can be considered to have used the Southeast Asian localities as way-stations, or secondary centers of dispersal.

In passing, we should pause to dispose of one possible objection to the hypothesis of direct or indirect diffusion from South China to Singapore: the argument that the change in environment would have necessitated a change in crops, farming methods, or both. This is simply not the case. As we shall point out in subsequent chapters, no supposedly unique quality of tropical soils (i.e. "laterization," low nutrient status, depth, etc.) is relevant, since the soil, in this farming system, forms little more than a support for the crop and a means of retaining air, moisture, and nutrients (all supplied, or at least encouraged, by farming practices) in the root zone. As to climate, the argument is equally invalid. Singapore's mean monthly temperatures, it will be recalled, vary from 78 degrees F. to 81 degrees. The mean temperature of the warmest month in coastal cities of South China is only slightly higher: Hong Kong (July) 82 degrees; Canton (August) 83 degrees; Swatow (July) 83 degrees; Amoy (August) 84 degrees. Granted, these higher midsummer temperatures could conceivably be a significant factor in subduing leaf-stem vegetable production in South China during the summer months: In Singapore, farmers find it necessary to cover beds of seedlings with palm fronds during the mid-day heat, and such a mechanism may have been absent in South China. On the other hand, the most serious detrimental effect of high temperatures would be to increase water needs of plants, and the summer half year is also the period of greatest water availability in South China. Unquestionably the leaf-stem vegetable supply to Hong Kong and Canton markets, and probably those of other cities, is reduced in midsummer: Herklots (1947) notes that the supply of most such crops dwindles to a trickle during this period. But the causal mechanism is unknown to the writer: Possibly it relates to a preference for wet rice cultivation, which lack of water prevents in winter. In any case, the problem would be irrelevant in fall, winter, and spring, when leaf-stem vegetable production is higher in South China and the most unambiguous similarities to Singapore exist. Ample evidence demonstrates that the coldest month mean temperatures in coastal South China (59 degrees, 56 degrees, 57 degrees, and 56 degrees for Hong Kong, Canton, Swatow, and Amoy, respectively) are suitable for vegetable production; further, the absolute minimum temperature for Hong Kong is 32 degrees, and the other cities also presumably suffer from few frosts, which, it should be noted, would not seriously hinder the production of short-term vegetables. As to the suitability of precipitation, we need merely note that it is the period of greatest relative drought -- all of the four Chinese cities referred to have four months with less than 2.4 inches of rainfall, and these occur in winter -- which is the period of greatest vegetable production.

And irrigation replaces rain water when the latter is inadequate.

As we shall indicate in the next chapter, leaf-stem vegetable production in Singapore seems to have begun in the alluvial flat near the mouth of the Kallang River, probably within a decade of the settlement's founding. Evidence which is purely circumstantial, but is nevertheless very impressive, suggests, as we have shown, that this farming system in the Kallang estuarine plain began as a transplant from China rather than as a native growth. We have no evidence concerning the character of the farming system during its earliest years, but, beginning with T. Oxley's account for 1836 (T. Oxley 1836), we have, gradually building up, a picture of a Chinese-operated farming system sharing many fundamental characteristics with South Chinese vegetable farming, and lacking most Malaysian characteristics (including, most notably, the important crops). Further, the area was producing for a Chinese urban population from the start. And finally, it encountered no environmental difficulties which South Chinese experience could not overcome with relative ease.

Origin of the Fruit-Earth Vegetable and Pig Farming System.--Forty per cent of Singapore's leaf-stem vegetable farms, and 80 per cent of those in the Lower Kallang Plain, probably the oldest farming area of this type, are operated by Cantonese. On the other hand, Cantonese comprise only 2 per cent of the surveyed non-leaf-stem vegetable farmers, and only 22 per cent of the total population of Singapore. This striking disproportion suggests differing modes of evolution for the two systems: either a common origin followed by a transfer in personnel in one or the other system -- from Hokkien and Teochiu to Cantonese or vice-versa -- or original association of a dialect-group with a farming system, and separate origin of each system in time or space. If the first possibility were true we should have to postulate a significant change taking place in the personnel of either or both systems after their origin, and this would have to have taken place after the systems migrated from China, or originated in Malaysia if such is the case.

The association of Hokkien-Teochiu dialects with fruit-earth vegetable and pig farming, and, to a less marked extent, of Cantonese with leaf-stem vegetable farming, can be explained by any of several hypotheses. One, and perhaps the most obvious, would relate the two Singapore farming systems to the types of farming characteristic of the two respective source areas, the Pearl River delta and surrounding portions of Kwangtung (for the Cantonese), and the Swatow-Amoy area of eastern Kwangtung and western Fukien (for the Hokkien-Teochius). According to this hypothesis, the leaf-stem vegetable system would be traceable to the Cantonese-speaking portion of China, and perhaps also to the Hokkien-Teochiu-speaking portion; but the fruit-earth vegetable system would have its origins solely in the latter area, since very few Cantonese are involved in it in Singapore.

A second hypothesis would sharply differentiate the two systems, allowing the leaf-stem vegetable system a Chinese origin (as we have argued), but postulating that the other system came into being in Southeast Asia rather than China, either in Singapore itself or elsewhere, having been developed or borrowed by Chinese immigrants. We have already shown that the leaf-stem vegetable system has Chinese antecedents, and have suggested mechanisms for its migration to Singapore. If we can locate the place, time, and perhaps ancestral farming system for the other (which may be termed a dry-soil farming system, since this less cumbersome title indicates one of its chief characteristics in Singapore -- vegetable and fodder-crop production on unwatered soil), either in China or elsewhere, and establish a mechanism for migration if transfer of place is involved, we can establish the probable validity of one or the other hypothesis. Unfortunately, no full demonstration is possible, and we shall have to be content with a probable answer. The problem is complicated by the fact that few of the 19th-century sources, and none of those of the 18th century, describe the agriculture of the Hokkien-Teochiu area in China.

One feature of the physical geography of coastal southern China would appear at first sight to favor the first hypothesis, that this area constitutes the source region of the dry-soil system. This is the evident fact that the Pearl River delta area possesses much more flat, alluvial land than the

Amoy-Swatow area. One might argue that an upland area would tend to spawn an upland farming system and a low alluvial area a system in which irrigation (hand watering) is important. It would then be argued that immigrant farmers from each region tended to adopt a mode of agriculture in Singapore closest to that of their place of origin.

Apart from the fact that an argument of this sort does little more than point to similarities between a "before" and an "after" situation, and depends on the always-questionable assumption that cultural inertia can be depended on to account for the similarities (culture change is, after all, as prevalent as inertia, and we are as much obligated to explain why something didn't change as to explain why something else did), a number of concrete facts appear to contradict it. First of all, there is evidence that at least some leaf-stem vegetable production existed in the Amoy-Swatow area, at least during the 19th century, and further evidence that the amount of land ecologically suited to leaf-stem vegetable cultivation, including both flat land and terraced -- i.e., artificially flattened -- land, was sufficient to sustain either a specialized market gardening system for such cities as Swatow, Chaochow, and perhaps Amoy, or at least a seasonal (winter) enterprise emphasizing leaf-stem vegetables. In addition, there is strong evidence that the production of fruit-earth vegetables and pigs, though perhaps not both in association, was carried on in the Cantonese area as well as farther east.

References to dry-soil vegetable cultivation in Amoy are numerous, though all refer to dates much later than 1819. Dennys (1867:249) refers to the production of sweet potatoes (which, with tapioca, are the most important fodder crop in Singapore) and peanuts in Amoy island. Pork, however, was brought to Amoy markets from the mainland. Sweet potatoes were also produced in the Swatow and nearby Chaochow areas (239). Hughes, writing in 1872, lists the following dry-soil vegetables for Amoy: "Groundnuts, beans, peas, sweet potatoes, yams, turnips...carrots, radishes...melons" (Hughes 1872:49). Pitcher, in 1909, lists "squash, sweet potatoes, Irish potatoes...egg plant, beans, turnips, peas, peanuts..." (Pitcher 1909:46). In addition, these and other writers provide accounts of the island's agricultural soils which indicate them to be generally light in texture, to be excessively well drained, and often to be unusable for terracing, or at least flat terracing.

On the other hand, the same writers mention the production in Amoy of leaf-stem vegetables (see above). But it can be argued that the mere presence of leaf-stem vegetable crops, even though most of these are varieties identical with, or at least similar to, those grown in Singapore today, does not establish the fact that leaf-stem vegetable production was sufficiently widespread in Amoy and (more important) its hinterland to create a strong likelihood of the system being exported to Singapore. In support of this argument, that the system was not sufficiently widespread for a high probability to exist of its having been borne to Singapore by Amoy men, we might note the fact that, although artificially flattened land in the Amoy-Swatow hinterland extends the area edaphically suited to leaf-stem vegetable cultivation, adequate water may not have been available in winter for a seasonal enterprise on rice farms. Although some rain falls in this area in winter, the portions which have light soils, and these are apparently more numerous than in the Pearl River delta, would nevertheless experience edaphic drought. A seasonal enterprise would be a far more logical source for an emigrating system of this sort than would specialized market gardening, since the former would, presumably, have been found on many if not most rice-producing farms throughout the entire region, while the latter would have been limited in both area and number of participants.

However, it would satisfy our conditions for emigration if even a reasonable proportion of the rice farms in this area grew leaf-stem vegetables as a seasonal enterprise, or even in kitchen gardens, and this seems highly probable in view of the presence in the area of leaf-stem vegetable crops and terraced rice cultivation. A kitchen garden requires little area, and thus a relatively small water supply. A trickle of water in ditches, or even a well, would suffice. Since leaf-stem vegetable crops are short-term, one might also expect many farmers to use them instead of the longer-term dry-soil vegetables as a winter catch crop even where conditions for their growth were not ideal.

Similarly, references to the production of fruit-earth, dry-soil vegetables in the Pearl River delta and surrounding uplands are not only numerous, but also go back to the 1751 reports of Osbeck and Eckeberg. Eckeberg (1771:292-296) provides a description of an annual cycle consisting of vegetables alone in a field whose ecology can only be inferred, except that it was too dry for rice, yet had some irrigation; the vegetables included several beans and sweet potatoes. In addition, some slopeland soils in this area were given over to dry-soil vegetables. Thomas, in his description of a trip up the western tributary of the Pearl River in 1903, says of an area some seventy miles above Canton:

> We notice large patches on the hillsides under cultivation and learn that there is a variety of sweet potato grown which requires very little water, and is therefore a very profitable thing to raise on what would otherwise remain simply waste ground (Thomas 1903:36).[2]

The foregoing evidence allows no definite answer to be given on the question of whether each of the two systems originated in the area in China from which present practitioners of the systems in Singapore originated. There seems a fair likelihood that leaf-stem vegetable farming existed in both Chinese areas -- but then we find both Cantonese and Hokkiens-Teochius practicing it in Singapore. Although Cantonese are considerably more numerous in the system in

[2]For other discussions of leaf-stem vegetables in the Cantonese area, see Barrow 1804:407; Abel 1818:63; Abeel 1836:78; Dennys 1867:137; King 1911:83, 87; Richthofen 1912:III,412; and later writers.

Singapore than one would expect from their numbers in the population as a whole, the probability is that more of the Pearl River delta emigrants possessed knowledge of leaf-stem vegetable cultivation than did the Amoy-Swatow emigrants, in view of the greater prevalence of suitable land in the former area; the strength of the Cantonese element in the system in Singapore may be explainable on this basis without denying that Hokkien-Teochiu immigrants probably also carried the system with them from the Amoy-Swatow area.

When we focus on the dry-soil system, however, the evidence summarized above in favor of an Amoy-Swatow origin appears quite unconvincing. This system in Singapore is almost exclusively a Hokkien-Teochiu enterprise, yet the evidence suggests its presence in the Cantonese-speaking portion of South China as well. We may offer the tentative conclusion that the system did not originate exclusively in the Amoy-Swatow area, and that, if it originated in China at all, it was joint property of both Hokkien-Teochius and Cantonese. This might suggest that a change took place outside of China at a later date, one in which Cantonese withdrew from the system. It might also suggest that the process of emigration itself placed the system in the hands of Hokkien-Teochius. Before we consider these and other possibilities, some of which involve an extra-Chinese origin, we must attempt to trace the individual process elements present in the contemporary Singapore dry-soil vegetable and mixed farming system back to South China as a whole, to determine whether any Chinese origin at all can be postulated.

It has not been possible to determine the extent to which dry soil vegetables, or non-leaf-stem crops grown in wet soils (e.g., taro), were used as stock feed in South China, and thus indicate an association between vegetable and pig production. In particular, the possibility that the large area devoted to sweet potatoes mirrors a stock emphasis has not proven capable of analysis. It will be recalled that pigs were brought to Amoy from the mainland, although fruit-earth vegetables were grown on the island, but we cannot determine whether this information is significant. The evidence on an association between leaf-stem vegetables and pigs in the Canton area presented earlier is equally inconclusive.

As to the kind of soil farmed, again no definitive evidence presents itself. Sweet potatoes were grown on hillsides, as they are in Singapore; but were other crops grown on terraces, which do not exist in Singapore? Eckeberg describes a pattern of vegetable beds which somewhat resembles that of Singapore fruit-earth vegetable beds: broad, relatively flat beds with deep furrows on the sides. But his description, which tallies with a photograph provided by King 140 years later, refers, in all probability, to irrigated flat land with lighter soils, rather than to slopeland -- the normal land-type farmed in this manner in Singapore (Eckeberg 1771:192-296; King 1911:73,89).

Tools appear to be similar in Singapore and South China, as does availability of water -- a broad range of adequacy in water supplies exists in both areas. Both appear to be less accessible to urban markets than is leaf-stem vegetable production in the respective areas. Both also possess high labor input, but this is a feature of all South Chinese crop farming systems. The types of fertilizer used for vegetable production are similar: Both use organics, both make at least some use of pig manure, and the heavy emphasis on the latter in Singapore may simply reflect the prohibition on the use of night soil, which is not present in China, where night soil takes on considerable importance. The degree of dependence on purchased stock feed, an important element in the Singapore system, is quite unknown for South China.

Perhaps the chief argument against the existence of strong homologues between the system in Singapore and vegetable and pig enterprises in South China is based on the fact that many of the common elements are also held in common by other types of farming, in fact are essential characteristics of South Chinese agriculture as a whole and would be expected to form a part of any South China-derived gartenbau system. On the other hand, the fact that nearly all crops employed in the system in Singapore are also grown in South China (tapioca may be an exception) is persuasive. We must conclude that no answer can be given to this question, unless we argue that the contrast between strong indications of a Chinese origin for the leaf-stem vegetable system and relatively weak indications for the dry-soil mixed-farming system throws into serious question such an origin for the latter system -- but this is not a convincing point.

There is, however, some positive evidence that the system did originate in Southeast Asia. Anticipating the evidence to be presented, we may say that there is a strong probability that the dry-soil mixed farming system, as a functional field, was assembled -- by Chinese -- in Southeast Asia, although many of its elements derive ultimately from China.

According to Purcell (1951), Hokkiens from Changchow (inland from Amoy) and Cantonese were settled near Surabaya in 1411. Elsewhere (1948) he states that Chinese may have been present in Malacca as early as the 16th century, i.e., during the Portugese period; at the time of the Dutch conquest of Malacca in 1641 there were between three and four hundred in and near the town (21). De Klerck (1938:260,268) remarks that Chinese were growing vegetables, sugar, and rice in the outskirts of Batavia shortly after its founding in 1619. Citing an early source, Purcell (1951) states that Chinese were importing pepper and other products from Sumatra, Borneo, and Malacca to Bantam (Java) in 1621. Chinese were, in addition, in Acheh (Sumatra) and Johore (Malay Peninsula) in 1698 (Bannister 1859).

According to Duyvendak (1927), the second half of the 17th century, a period of unrest following the Manchu conquest, was one of heightened emigration to the Nanyang -- Southeast Asia -- although emigration had been important during the Ming dynasty as well. Fukien, he suggests, supplied the bulk of the emigrants. Purcell states that "there is ample confirmation...that the early Chinese in Malacca came from Fukien province" (1948:21). According to Shellabear,

> The first immigrants to Malacca were probably from Amoy, for nearly all the words of Chinese origin which have come into the Malay language approach more closely the sounds of the Hok-kien than to those of any other dialect, and...all the old families claim to be Hok-kiens (1913:49-63).

Stevens (1929:373) reports that Chinese held much of the cleared land in Penang in 1795; in one area described by him, and comprising perhaps a sixth of the cultivated acreage, most farmers were from Amoy.

We may conclude, therefore, that Chinese were in the areas surrounding the Straits of Malacca very early, and most, though by no means all, of the early arrivals were Hokkiens. Whether or not they were growers of fruit-earth vegetables is uncertain. But by the time the British obtained their first toehold in the Straits -- the settlement of Penang in 1786 -- the Chinese had become identified with two exceedingly important export crops of the area, pepper and gambir, and most probably it was Hokkiens who grew the crops.

Pepper (<u>Piper nigrum</u>) production in Southeast Asia may date from before the Christian era (Blacklock 1954). The association of Chinese with the crop seems to have begun with the pepper trade between Southeast Asia and China: Blacklock states that pepper was sent from Java to China in the 13th century; Winstedt (1949:117) cites a source from 1516 describing the production of pepper in Acheh and the Malay peninsula and its conveyance to Malacca and thence to China; and Purcell (1951) refers, as we have seen, to the production of pepper in Djambi (Sumatra), Borneo, and Malacca, and its conveyance by Chinese to Bantam for shipment abroad in 1621.

Exactly when the Chinese became producers themselves is not known to the writer. However, by the end of the 18th century Chinese were planting pepper in Siam (Koenig 1779, transl. 1894:No.26,177), Penang -- having brought the crop there from Acheh in about 1786 -- and almost certainly in Malacca, in other parts of Malaya, in Sumatra, and probably elsewhere. While we have no direct evidence that pepper production was solely, or even largely, in the hands of Chinese planters in the 17th and early 18th centuries, they were closely identified with this crop by the end of the latter century. When Bort, an early Dutch governor of Malacca, stated in 1678 that "this country must have a larger population, especially of the industrious Chinese, so that the necessary cultivation of the soil may continue" (Dort 1678, transl. 1927), we may presume that he was referring to Chinese pepper planters. Most important for our purposes, by 1819, the year when Raffles landed in Singapore, the Chinese seem to have become dominant in pepper production in Malacca, Penang, and probably nearby Rhio, the three Malaysian areas most closely associated with the origins of Singapore's Chinese population and the island's economy (Low 1836, cited in Purcell 1948:44).

Gambir (Uncaria gambir), a climbing shrub, the leaves of which were used in a masticatory preparation (similar to the present betel chew), as a medicine, and, during the 19th century, as a substitute for cutch in tanning, is unimportant as a commercial crop today. During the 18th century it was grown in several places in Southeast Asia, and during the 19th, after having adhered to pepper production in a kind of symbiotic cropping system, it became quite important in and around Singapore. Winstedt (1949:117) states that gambir was brought from Sumatra to Rhio (a Dutch-controlled archipelago immediately south of Singapore) in the middle of the 18th century "for Chinese to plant." Koenig describes its production by Chinese in Malacca in the 1770's (Koenig 1779, Transl. 1894:No. 27, 121). By 1820, according to Crawfurd (1820:406), gambir was being cultivated at Siak, Kampar, and Indragiri along the east coast of Sumatra (directly opposite Singapore), at Malacca, at Rhio, and along the west coast of Borneo. Also, it appears, there were two or more Chinese gambir planters in Singapore Island itself in 1819, before Raffles' party landed there (Bartley 1933:176). Crawfurd (1820:406) states that gambir "culture and manufacture is generally in the hands of the Chinese" in Malaysia. Thus, by the time Singapore was founded, Chinese had become identified closely with two crops which were of perhaps greatest importance in the external trade of Malaya and western Indonesia of that time.

We do not know when and where the cultivation of gambir became fused to that of pepper in a single complex cropping system, a distinct functional field. Almost certainly this was a Chinese innovation: Not only were Chinese producers and traders in both crops, but production of both took place generally in the same, Chinese-settled, localities. The form of relationship between the two, involving as it did the use of organic residues from gambir to fertilize pepper, was, again, reminiscent of Chinese farming. As to the time and venue, we can only bracket in the period between the late 18th century and the year 1832, when the first conclusive evidence with which the writer is familiar emerged -- this from Singapore itself (Bennett 1835) -- and the area stretching from Acheh, through the Straits of Malacca, to Rhio (especially Bintang Island), and perhaps even to southern and western Borneo. Buckley (1902:I,154) refers to a comment by Crawfurd in 1824 which rather suggests the existence of the system in that year. However, in his comprehensive History of the Indian Archipelago published in 1820, Crawfurd devotes considerable attention to each crop in separate parts of the work (gambir:I,405-406; pepper:I,479-486), but never mentions any association between them, even listing different areas as important producers of each in turn. He further states (486) that no manure is used on the pepper, implying that gambir leaves were not available. However, although Crawfurd was an acute abserver, and knew Malaysia well, he may not have been thoroughly familiar with the Dutch-controlled Rhio Archipelago, a likely place for the pepper and gambir complex to have originated. As to why the fusion of the two crops took place, we can only suggest that the Chinese planter familiar with both crops might logically be expected to seek out a use for the residue from gambir production (boiled-out leaves for the most part), would most probably decide that the best use for the material was as a fertilizer, and would certainly know that pepper could make good use of the organic fertilizer.

It remains to be argued that Hokkiens and perhaps Teochius were the predominant Chinese group in pepper and gambir production. On this point we can merely summarize the somewhat inadequate evidence favoring this hypothesis, while noting that no contradictory evidence has been uncovered.

Perhaps the most important evidence lies in the fact that Hokkiens seem to have been the earlier arrivals (see above), and to have formed the bulk of Chinese settlers in Malaysia during the century or so preceding the founding of Singapore, the period when pepper production was emerging as an important occupation of Chinese settlers in the Nanyang. In addition, it appears that Hokkiens were in a firmer economic position than Cantonese in early Penang, Singapore, and Malacca, probably as a result of their longer sojourn in the Nanyang. Buckley, paraphrasing a note by Crawfurd in 1824, states that

> The Chinese in Singapore were of two classes, Macao and Hokien, the latter the most respectable and the best settlers; all the merchants and most of the good agriculturists were Hokien (1902:I,154).

"Good agriculturists" in Singapore of 1824 were pepper and/or gambir cultivators -- these being the chief crops of the time and place -- and especially the larger entrepreneurs, who hired numbers of sinkhehs -- newly arrived, penniless immigrants -- to work on their gardens. Crawfurd (1820:137) also comments that the Chinese in Malaysia who are from Fukien "bear a much better character" than those from Kwangtung. The former "are rarely from the lowest orders of society, and they are less gross and abject in their manners." This tends to support the hypothesis that Hokkiens were economically in a higher position than Cantonese. Merchants (all of whom were Hokkiens, according to Crawfurd) figured heavily in pepper and gambir cultivation also: A sinkheh, having served his period of indenture, would frequently obtain a "stake" from a merchant to develop his own small pepper and gambir garden, or bangsall, pledging the entire cultivation as security, and usually losing it to the merchant (Balestier 1848:145; Cameron 1865:42). Logan (1854:3) describes a parallel process in Penang. There, although "Quantung men" were the pioneers in opening up and cultivating new lands, Hokkiens were the creditors, and eventually took over the bangsalls. Admittedly, adding Crawfurd's and Logan's comments to the previously discussed evidence that Hokkiens were the pepper producers in pre-1819 Malaysia leaves us with less than convincing evidence that Hokkiens dominated pepper and gambir bangsalls of early Singapore; but opposing evidence is lacking.

One characteristic feature of Chinese immigration to the Nanyang may be called in here as further, though circumstantial, evidence to provide firmer grounds for the assertion that Hokkiens and perhaps Teochius were the dominant group in the Singapore bangsalls. As a rule, when Chinese of one dialect-group pioneered or cornered an industry or occupation in an overseas area -- Malaysia, the West Indies, the United States -- later immigrants belonging to the same dialect-group tended to enter the same industry or occupation. This process was assisted by many formal and informal social patterns: One immigrating member of a family or resident of a village would tend to bring over in his footsteps, and assist, additional emigrants from the same family or village; and informal societies such as the kongsis of Singapore, whose membership was drawn from among emigrants from one area in China, would provide living quarters for the newly arrived sinkhehs, and, since the members tended to follow similar occupations, would assist the sinkheh to get a start in these occupations. (Cf. in this connection Purcell 1948.) The existence of these patterns suggests that, the Hokkiens having once identified themselves with pepper and gambir cultivation, additional immigrating Hokkiens would take up the same occupation. Even more circumstantial, but perhaps even more persuasive, evidence supporting this point is the fact that a well-to-do Singapore Hokkien merchant would be expected to show more willingness to advance money to a man speaking his own dialect, whether this results from altruism -- aiding a countryman -- or selfish motives -- the lowered risk where the debtor belongs to the same, if somewhat loosely organized, community. Or, a

Hokkien entrepreneur, either a planter himself or a merchant owning a bangsall, who went to the godowns to bid for the indenture contracts of newly arrived immigrants, would be expected to prefer Hokkiens over others with whom he could not communicate because of a dialect difference. Thus he would further assist the Hokkien group to become dominant in pepper and gambir, since many if not most of the new bangsalls were operated by ex-indentured laborers who themselves had worked on merchants' bangsalls during their term of indenture.

If Hokkiens and perhaps Teochius were indeed the pepper and gambir planters of early Singapore, and thus practically the only farmers in the interior uplands, the hypothesis suggests itself that the origins of Singapore's present-day fruit-earth vegetable and pig farming system -- which, as we have seen, is distinctly a Hokkien-Teochiu farming system --are to be sought in some sort of transformation of the bangsalls into vegetable and pig farms. This hypothesis seems an agreeable one: It explains the strong association of Hokkien-Teochius with fruit-earth vegetable and pig farms, and does so somewhat more simply than does the alternative hypothesis that the system originated in China. The later begs the question why Cantonese are nearly excluded from this farming system in Singapore. To explain the association of Hokkien-Teochiu farmers with this farming system in terms of a Chinese origin for the system, one would have to point to the existence (or significance) of the system in Fukien and eastern Kwangtung and its absence (or insignificance) in the

Cantonese-speaking portion of South China. The evidence for such a contrast between the two nearby areas in China is meagre, though not entirely absent. The evidence for the alternative hypothesis -- Chinese origin of the leaf-stem vegetable system and Malaysian origin of the fruit-earth vegetable and pig farming system -- is stronger. To the foregoing body of evidence, two further "legs" of the argument must be added: first, the mode of transformation of the pepper and gambir planting system into a vegetable and mixed farming system; and second, the explanation for a higher proportion of Cantonese farmers in leaf-stem vegetable cultivation than in the overall population (and thus, by inference, the immigrating population) of Singapore. First, however, a brief description of the pepper and gambir farming system should be presented.

According to Crawfurd (1820:482), pepper grew "in the most indifferent soil." This "indifferent" soil he identified as "dry upland." Bennett, writing in 1834, states that "the situations selected by the Chinese in this undulating country [Singapore], for their farms and plantations were upon, or close to the sloping hills; and these places are selected for the Gambir and pepper plantations, the lower lands proving too swampy" (1834:180). Koenig, writing in 1779, states that gambir was grown on hillsides in Malacca (Koenig, op. cit., 1894:No.27,103). Ridley, in an agricultural bulletin dealing with gambir published in 1891, states that gambir planters preferred sandy soil -- the sort found largely on uplands in

Singapore. Thus it is clear that pepper and gambir <u>bangsalls</u> in Singapore were to be found on the same sorts of land later occupied by the fruit-earth vegetable farms -- upland, well-drained soils, and probably also the limited areas of sandy, well-drained alluvium.

A rather quaint and perhaps slightly prejudiced account of pepper and gambir production, one which accords in most respects with other reports, was written by Balestier in 1848, at the height of the pepper and gambir boom:

> The Chinese undertook the growth of Gambier and Pepper, and gradually have extended themselves over a considerable portion of the Island. But they are evil doers rather than doers of good to the land, which after a few years cultivation they abandon, impoverished and overrun with lalang grass, and remove to a fresh clearing in the jungle, where the virgin soil becomes in turn exhausted and a nuisance.
>
> The emigrants from China who yearly arrive here are of the very lowest classes of laborers in their own country, and for the most part enter into engagements with their countrymen already established here to labour for one year, in consideration of the payment of their passage money hither. At the end of the year, if perchance they have not quietly emancipated themselves before, they are free to do as they please, and as they are mostly taken up by the Gambier and Pepper planters they usually bargain with a Chinese shopkeeper in Singapore for money and provision to enable them to set up with, pledging the future plantation and its products on conditions highly favorable to the capitalist. After having found a suitable location they squat upon it, not infrequently without even applying for a license...from the local authorities. A clearing is soon made in the forest, a part is planted in Gambier and a part in Pepper, the fallen trees being preserved for future use in boiling the leaves of gambier into a strong decoction which on cooling hardens somewhat in appearance to soap. Now the Pepper vine, to be vigorous, and productive, requires a good deal of manure, and the exhausted leaves of Gambier are

> carefully preserved to be afterwards deposited at the roots of the pepper vines, and this is the only manure they receive, while to the Gambier plants none whatever is given. The ground is gradually impoverished; becomes less valuable; lalang soon begins to shew itself among the plants; as the cultivator is not the proprietor but a squatter, and as he has abundance of fresh ground at hand, and believing it to be more for his interest to begin a new plantation than to be at the expense of procuring manure to keep the old one in good order, it is not a wonder that he should remove from place to place, and, as the locust, leave a tract of desolation behind him (Balestier 1849: 145-146).

The "tract of desolation" was not a continuous area behind an advancing frontier of bangsalls: The latter were located at some distance from one another, separated by tracts of forest which served as firewood reserve, probably also as camouflage from bandit gangs and government surveyors (the farmers were generally "squatters" -- unauthorized occupiers of Crown land), perhaps also to "screen against lalang encroachment" (Ridley 1891:27), but probably not, as some have supposed (Cameron 1865:86), to provide shade for the crops. We cannot build up a precise, mappable picture of the locations of bangsalls in Singapore during the pepper and gambir boom of the 1830s, but the general pattern is clear enough. Bangsalls were located well into the interior -- that is, north, northeast, and northwest of the town -- and were probably most frequent in a band of country near, but not adjoining, the settled portion of the country. In addition, many were located on the coasts and tidal rivers around the island, the produce being shipped by boat to the town. Gradually cultivation spread outward; by 1870 or thereabouts nearly every upland area with suitable soils had been occupied at one time or another by a bangsall. In 1827 Prince, the Resident Councillor, travelled some seven miles into the interior of the island from the town, and estimated that three-quarters of the distance was through pepper and gambir (Buckley 1902:I, 198). At that time most of the interior, away from the town and coasts, was still virgin forest. After 1830, the year when gambir was first shipped to England, cultivation expanded at a more rapid rate. By 1848 the cultivated acreage had begun to decline, for reasons to be discussed shortly; many planters had moved their operations to Johore. Even in that year, however, nearly 40 square miles (out of the island's total of about 220) were occupied by the bangsalls.[3] This figure becomes more impressive when we consider that the bangsalls were, apparently, moved after a single pepper cycle of fourteen or fifteen years, and each used up roughly as much additional forest land for firewood as it did for planting. This suggests that more than two-thirds of the island's area had been cut over in a period of three decades. In 1860 the Surveyor General estimated that 25,000 acres were under cultivation in the island -- this must have been largely pepper and gambir -- and an additional 120,000 were lying waste (Cameron 1865:173). This is almost exactly the area

[3]Calculated from Thomson (1849:134-143), who provides an estimate of the number of bangsalls -- 800 -- and the average size -- 30 acres.

of the island as a whole.

As Balestier indicated, the typical vegetation type occupying abandoned bangsalls was lalang grass (see Chapter IX). Ridley, writing in 1891, reported a "great extent of lalang grass," at the same time noting that a very small amount of gambir (and probably also pepper) was still being produced in the colony. Although the lalang may have been succeeded by blukar -- bush -- in some areas, the very broad areas it covered must have seriously inhibited reseeding by woody species, and most grasslands probably remained such up to 1891. In 1905 Ridley (who was a botanist) commented that

> Immense areas of land were spoilt by the Gambir, Pepper, and Tapioca planters, and a good deal after a few years' use has never been touched again for 50 years...Most of the land in the Colony which was at one time under cultivation and abandoned has never been utilized a second time (1905:300).

The peak in gambir and pepper came before 1850; later came a partial rally with higher prices and more labor, but the industry was insignificant after the third quarter of the 19th century, and it disappeared entirely in 1920. Parallelling the decline in Singapore came a growth in Johore; many planters simply abandoned their Singapore holdings and began clearing land across the Straits of Johore.

After the decline and fall of pepper and gambir in Singapore, some land -- probably rather little -- was put into pineapples and tapioca. The former became the principal Chinese crop of the island; the latter, which was of some importance until the 1880's (Makepeace 1931:83), was at least partly a Chinese crop. It is no coincidence that tapioca and pineapple (where the latter is grown on upland soils) are among tropical crops requiring the least in a soil. In all probability tapioca, and pineapple if it was grown as an upland crop in Singapore, reoccupied land formerly under pepper and gambir. But neither enterprise was of very great significance, either economically or areally. Between the fall of pepper and gambir and the beginning of the next great boom in Singapore agriculture -- rubber planting after about 1905 -- most land was, as Ridley suggests, abandoned, lying in lalang waste.

In the next chapter we shall argue that leaf-stem vegetable cultivation during the 19th century was in Cantonese hands, and was probably confined to the alluvial lowlands adjoining the town itself -- land which today is largely built up. If the second assertion is correct, and if the pepper and gambir association was a Hokkien (or Hokkien and Teochiu) enterprise, one must conclude that the agriculture practised in the interior of Singapore Island was largely in the hands of Hokkiens during the 19th century. We can further state that -- with the possible exception of pineapple cultivation -- it was largely upland, dry-soil, farming. We must next consider whether any direct or indirect evidence supports the hypothesis that Hokkien farmers of the interior shifted to the dry-soil vegetable and pig cultivation found there today.

The number of farms involved in this shift need not have been very great. If we assume the same ratio of vegetable farms to total Chinese population in Singapore in, say, 1870 as pertains today, the number of vegetable and pig farms may have been of the order of 250-300, occupying 1000 or so acres. By contrast, there were at least 800 pepper and gambir bangsalls two decades earlier, many of them with sizeable labor forces. While many, perhaps most, pepper and gambir planters moved to Johore, a few remaining ones could have supplied Singapore's need for earth and fruit vegetables and for pigs.

Vegetable production seems to have been associated with pepper and gambir production from before the time when Singapore was founded. Hunter (1886) states that the system employed in starting a pepper plantation in Penang of 1802 involved contracting for a five-year period -- that is, allowing a farmer, sinkheh or otherwise, the privilege of growing his own crops on a piece of newly cleared land while tending the young pepper plants. This system (used in many parts of the tropics with divers crops) has almost invariably involved the short-term production of vegetable crops by the contractor, who moves to another new planting when the contract period is up. The system seems to have operated in Singapore as well, the contractor being allowed to grow vegetables for home consumption at the very least. Those farmers who operated their own farms on an advance from town merchants probably had to grow and sell short-term crops during the interval between planting and full bearing of pepper and gambir (at least four years and two years, respectively) in order to obtain cash. Bennett (1834), while noting that most provisions and vegetables were brought into Singapore from Malacca and the islands surrounding Singapore at the time, also remarked that "vegetables of different kinds, the sugar-cane etc. are also cultivated for the supply of the Singapore market" on pepper and gambir bangsalls (180). Further evidence that earth and fruit vegetables were for sale in Singapore in 1836 is provided by V. Oxley who, in an article printed in the Singapore Free Press of that year, states that "in walking through our markets it is enough to give one dyspepsia to see the tough and wretched production exhibited in our stalls. The rank loba or native radish, the stringy kidney bean, the coarse sisawee or mustard, make one ready to cry out oh!...such unassimilating rubbish" (V. Oxley 1836). It is also worth noting that a list of imports from Malacca to Singapore for 1837 does not mention vegetables, though it does pigs and fruit (Moor 1837:244). In 1841 Low commented, in an article in the Free Press, that "the Chinese and Malays raise in their own way all the vegetables which are brought to market." These included sweet potato, yams, and taro, the stalks and leaves of the latter being sold as pig fodder (Buckley 1902:I,361). In a paper written in 1849, Thomson supplies a list of over a dozen dry-soil vegetables, indicating that their cultivation "is almost entirely in the hands of the Chinese," but not specifying a connection with the bangsalls (Thomson 1849:137). In the same year a Malacca planter published an article giving suggestions for those wishing to start coconut and Areca plantations in that settlement, and stressed the desirability of having the Chinese laborers (contractors?) grow vegetables and pigs to market themselves among the major plants during the early years of the planting, remarking that he followed this procedure himself (Baumgarten 1849:713, 714, 718). Wallace, the naturalist, visited the island several times between 1854 and 1862, publishing his observations later in his Malay Archipelago. He stated that "in the interior of the island the Chinese cut down forest trees in the jungle and saw them up into planks; they cultivate vegetables, which they bring to market; and they grow pepper and gambir" (Wallace 1902:17). Thomson, writing in 1875 about Penang, describes Chinese planters spread throughout that island, living on "their small vegetable gardens or pepper plantations" (Thomson 1875:13). Referring to Singapore, he speaks of "herds of wild pigs (which) roam wild in the jungle, the pests of the Chinese squatters, whose sweet potatoes and other produce they ravenously devour" (73). In 1880 a visitor to the island, describing the Singapore market in early morning, mentions "Chinese coolies coming in from the interior of the island laden with fruit and vegetables" (Burbidge 1880:16). Somewhat later, Ridley (1910:450) refers to the scarcity of vegetables in the island at that time, blaming this in part on the fact that large areas formerly in vegetable gardens had been planted to rubber; and, it should be noted, rubber was primarily an upland crop, although in the early days of the boom it was planted on alluvial lands as well. The following year, in a paper on Chinese swine culture in Singapore, Ridley describes a system of pig production essentially the same as that found among Hokkien upland farms today: heavy emphasis on green vegetable food, including sweet potatoes and the recently introduced water hyacinth. He does not, however, mention any sale of vegetables from pig farms (Ridley 1911:149-150). In 1921, Makepeace alludes to the "disappearance of the small fruit and vegetable cultivator from many parts of the island," as a result of the "rise in the value of land due to the prosperity of the rubber industry" (Makepeace 1921:314). (By this time the planting of rubber in poorly drained lowlands can be assumed to have ceased; the farms referred to are thus almost certainly upland ones.) And finally, a topographic map published in 1924 (Straits Settlements, Surveyor General) shows vegetable cultivation in many upland areas which today are important producers.

The foregoing summarizes essentially all available evidence on dry-soil vegetable cultivation and pig farming during the 19th century. From this point we must proceed by inference.

First, it is clear that upland vegetables were being produced in 19th century Singapore, at least after 1836. Pigs are referred to by several writers after 1849. The association of vegetables with pepper and gambir was noticed by Bennett (in 1836) and Wallace (between 1854 and 1862). We might, if we wished to, postulate a double change in agricultural personnel, first, the Hokkien pepper and gambir planters (always assuming that we are correct in identifying this dialect group with the <u>bangsalls</u>) leaving Singapore for Johore, second, a new group of unknown dialect coming in to plant vegetables and raise pigs during the latter half of the 19th century, and third, other Hokkiens (or this second group) becoming the vegetable and pig farmers on contemporary upland farms. But it would be preferable, and simpler, to reconstruct the picture differently, in such a way as to require no such change in personnel. According to this view, we would have <u>a few</u> Hokkiens remaining on the land in Singapore, and responding to the decline in gambir and pepper not by moving to Johore, but by altering their farming enterprises to suit the new conditions. Some would have taken up pineapples, others tapioca, and still other vegetables and pigs. Implicit here is a re-orientation in values toward land, the essential motivation being to maintain soil productivity over a long period of time rather than to abandon a planting after one fifteen-year pepper and gambir cycle. However, this would pose no difficulty for the Chinese farmer, familiar as he was with methods of soil maintenance based on contour tillage and organic fertilization. Indeed, it would be surprising if a mixed farming system with dry-soil vegetables and pigs had <u>not</u> evolved as the mechanism employed by the Chinese farmers for remaining on the land after pepper and gambir production had ceased to be profitable.

All explanations of the decline of pepper and gambir in Singapore with which the writer is familiar blame soil erosion or depletion for the flight of the industry. This appears to be an over-simplification. So long as abundant land was available, and in view of the fact that clearing of forest was an integral part of the farming system in any case, it was economically more feasible to practice the form of shifting cultivation described than to attempt permanent cultivation in one place. It is even doubtful whether gambir, and perhaps pepper as well, could have been grown profitably in Singapore under a permanent cropping system, since the system actually used brought great quantities of fertilizer to the pepper plants at little cost, the gambir being itself unfertilized, while a permanent cropping system would have required a source of fertilizer for the gambir. It thus appears that a conscious choice was made in favor of land abandonment by a farming group amply capable of maintaining the soil, had it so desired. The intrusion of lalang probably did reflect soil depletion, and perhaps also erosion in places, but this grass entered the picture only as a result of land abandonment: Fighting off the grass during the cropping cycle itself was at worst a problem in cost. The origin of the vast expanses of lalang characteristic of Singapore during the latter half of the 19th century was, as we have indicated, a result of land abandonment over large, continuous areas, allowing the lalang to attain a ground cover sufficiently extensive to seriously inhibit the return of woody species. We conclude, then, that it was the absence of any alternative form of land use which would have justified, for the Chinese farmer, the considerable cost of maintaining soil fertility and keeping down lalang, that accounts for the abandonment of Singapore's uplands and the spread of lalang during the second half of the century. Had Singapore's soils been fertile enough to encourage the production of nutmeg or some other then-valuable permanent crop, or had the prices of pepper and gambir been higher, the abandonment would not have taken place.

Proof that the Chinese farmers could, and sometimes did, force out the lalang during the period before rubber entered the picture -- after which nearly all lalang was eliminated as rubber planting proceeded -- is provided in an article published by Lim in 1908. Significantly, the farming system which he describes as being the one employed after the lalang had been cleared was vegetable cultivation, and the key element was manure -- probably pig manure. First, lalang was hoed out, the roots being raked and burned. Second, rapidly growing vegetables providing good cover, cucurbits, for example, were planted in heavily manured beds. Within three months the ground was covered by vegetables and lalang could not return. A second crop, then a third were planted immediately thereafter, with heavy manuring and scrupulous weeding continuing. Following the cucurbit, typically, came chili, then a legume, then the sweet potato, then tapioca. By the end of this period of perhaps three years lalang was no longer a menace. It appears that only vegetable farming, probably combined with the pig enterprise, justified clearing the lalang before the advent of rubber, and we can infer that only a shift to vegetable farming could have prevented _lalang_ from intruding into a _bangsall_ after the pepper and gambir cycle had been completed. If, then, we make the final assumption that some farmers -- perhaps those who lacked the capital to move to Johore, or those occupying marginal land toward the end of the pepper and gambir era when nearby land in Johore had all been planted -- elected to remain on their Singapore farms, the hypothesis that a transformation from Hokkien-operated _bangsalls_ to Hokkien-operated vegetable farms took place becomes an acceptable one. Again we should point out that few farms need have been involved, and that the process can have been a slow and imperceptible one for the transformation to have been effected, and to have been completed by the time rubber entered the picture. In a survey carried out by Thomson in 1849, vegetables (of which there were at that time 379 acres) had a value estimated at $91 Spanish per acre per year, while the corresponding value for pepper and gambir was $7, and that for all other crops not over about $16. This suggests that the value of production of an acre of vegetables was sufficiently high to justify the cost of clearing, or of keeping out, _lalang_, i.e., that factors inhibiting the expansion of vegetable acreage did not include the presence of _lalang_ on a piece of land; not so, evidently, for other crops at the time. (Thomson 1849-1850:Part 4,219.)

We thus conclude that the hypothesis of a Singapore origin for the dry-soil, fruit-earth vegetable and pig farming system seems more tenable than the alternative one of a Chinese origin.

However, while we postulate the erection of this functional field in Singapore, we do not argue that most of its essential elements can not be traced back to China. Had there not been an era of pepper and gambir, with Hokkiens operating the bangsalls, the present pattern of dry-soil vegetable and pig cultivation might still have been somewhat similar to what it is. But its domination by Hokkiens and Teochius would probably not have occurred.

Finally, a word of qualification: It will be noted that the foregoing discussion applies to what might be viewed as a culture complex, an integrated system of behavior, attitudes, and materials. It does not apply to a particular group of individuals as such. As it happens, most of the dry-soil vegetable farmers interviewed in 1952 had been born in China. But among those born in China most stated that they had learned to farm not in China but in Singapore. (The number of non-Cantonese, China-born, dry-soil vegetable farmers in the Yio Chu Kang and Lokyang farming areas who stated that they had learned to farm in Singapore was forty; the number of like farmers who stated that they had learned in China was fourteen.) Thus we can argue that the farming system had its origins in Singapore even though its personnel received frequent additions from China. Granted, the addition of personnel, culture-bearers, from China meant that countless Chinese ideas about farming -- techniques, crops, and the like -- were available for incorporation into the system, and doubtless many of these ideas were adopted. But the fact that most of the process elements in the dry-soil (fruit-earth vegetable and pig farming) functional field seem to have been present in China of a century or more ago, combined with the fact that culture-bearing immigrants were arriving from China then, too, suggests that few major changes in the system can be attributed to the surviving immigrants, even though they constitute the majority of farmers practising this form of agriculture today.

CHAPTER XI

HISTORICAL GEOGRAPHY OF THE LEAF-STEM VEGETABLE FARMING SYSTEM, 1819-1953

The First Decades.--While the earliest references to leaf-stem vegetable cultivation in Singapore go back to the first decade of the colony's existence, the historical record from then on is meagre. Except for inferences, some firm, others rather shaky, we shall have to be content with a somewhat sketchy history of the farming system, one which cannot properly qualify as a processual account.

It will be recalled that a South Chinese origin has been assigned Singapore's leaf-stem vegetable farming system. The fact that about 40 per cent of Singapore's leaf-stem vegetable farmers are Cantonese, as against about 22 per cent in the total population of the island, and the perhaps more significant fact that 80 per cent of the farmers in the island's oldest leaf-stem vegetable farming region (the Lower Kallang Plain) are Cantonese, suggests that origins are to be sought in the Pearl River delta,[1] the source-area of Cantonese immigration. However, we have called attention earlier to the evidence for the existence of at least some of the process elements associated with this system in the Hokkien and Teochiu source-areas,

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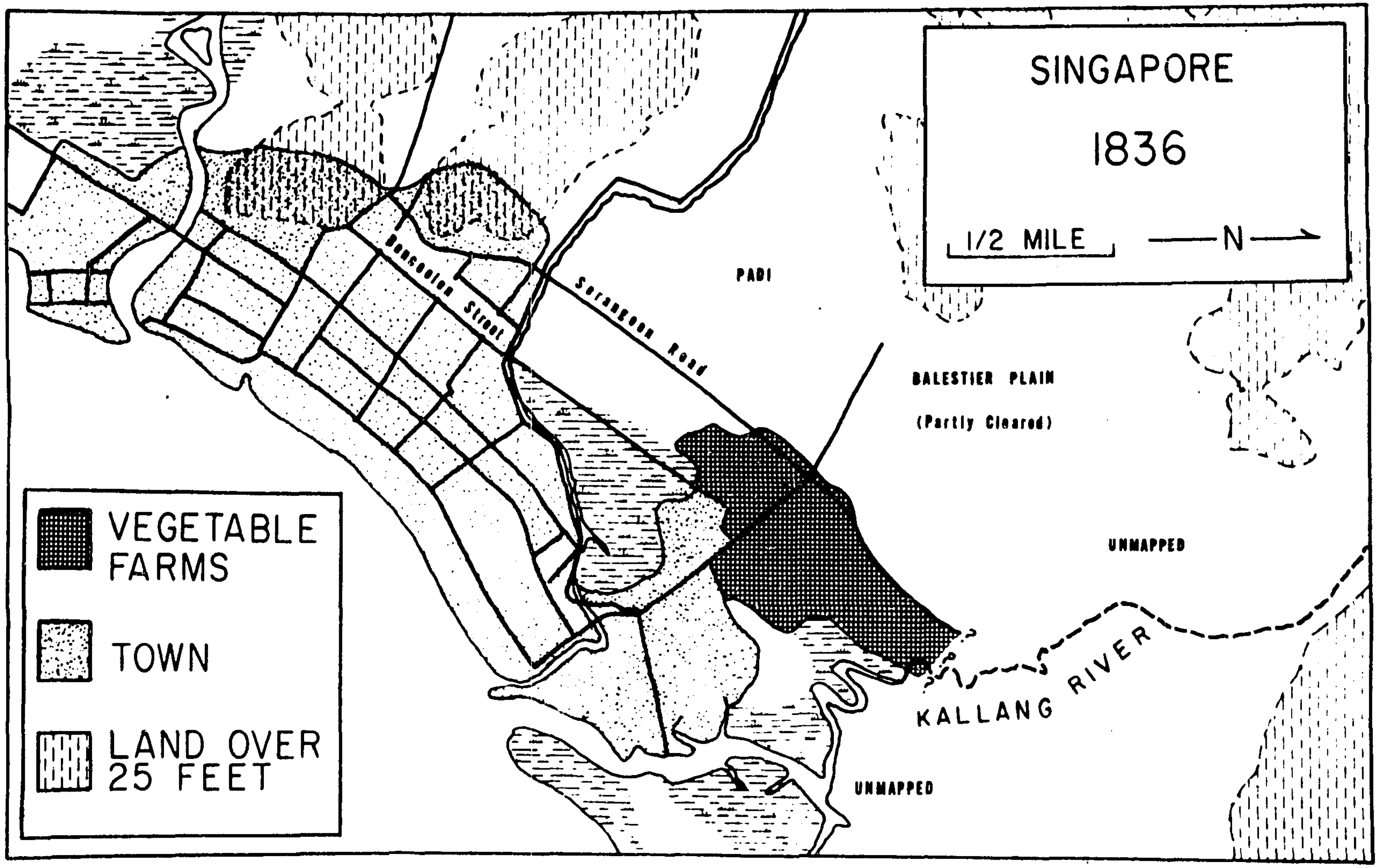
[1]Including adjoining areas, such as coastal Kwangtung west of Macao.

so we cannot rule out the possibility that Hokkiens carried the system to Singapore and only later were replaced by Cantonese as the operators of farms of this type. Applying Occam's razor, we should select the hypothesis of a Pearl River delta origin, since this requires no shift of farming personnel after the system arrived in Singapore. Against this might be offered the evidence that Hokkiens seem to have been the earlier immigrants. But this evidence carries less weight than might be supposed. We know that many Hokkiens came to Singapore from Malacca and Penang during the earliest years, but they came for purposes of gain; it is difficult to imagine immigrants who had amassed sufficient capital to bring them, not as indentured laborers, from Malacca or Penang to Singapore, taking up an occupation which must have been among those promising least, and slowest, profit, when pepper and gambir or urban occupations promised much greater and faster gain in the booming young colony. When Crawfurd stated that "most of the good agriculturists were Hokien," he was, as we have suggested, speaking of pepper and gambir planters, not market gardeners. The merchants of the time were all Hokkien; these would almost certainly have been the Penang and Malacca men with capital who moved to Singapore, not the usually penniless immigrants from China. By the same token, it is much easier to assume that the indentured laborers would gravitate to an occupation requiring little capital when their terms of indenture were up, and market-gardening would qualify as such an occupation. Hokkiens, we have suggested, had a greater opportunity to try their hand at pepper and gambir, and probably to enter business organizations (such as shops) in town, than did Cantonese, since representatives of the former group held capital, businesses, and bangsalls in the early days of Singapore. Therefore, very likely the leaf-stem vegetable farming system, a small-scale, low-capital-input form of enterprise, became largely Cantonese almost by default. In the case of an enterprise operated at such a small scale -- we have no reason to believe that market gardens of 1820-1830 were larger than family-sized farms since they are such today -- the possibilities for a "cultural monopoly" by the Cantonese would be less than with Hokkien pepper planting and retail trade, since no restrictive mechanism such as capital or employment by members of the same group would have been involved. Presumably, any immigrant with enough cash to hold him until he harvested his first crop of vegetables -- and leafy vegetables, it should be noted, mature in six weeks -- or a part-time occupation leaving him enough time to start a farm, could take up leaf-stem vegetable farming. If these assumptions are correct we have an explanation for the strong Cantonese strain in this farming system, and also an explanation for the fact that leaf-stem vegetable farming is much less Cantonese than is dry-soil vegetable and pig farming, or was (we believe) pepper and gambir planting, Hokkien.

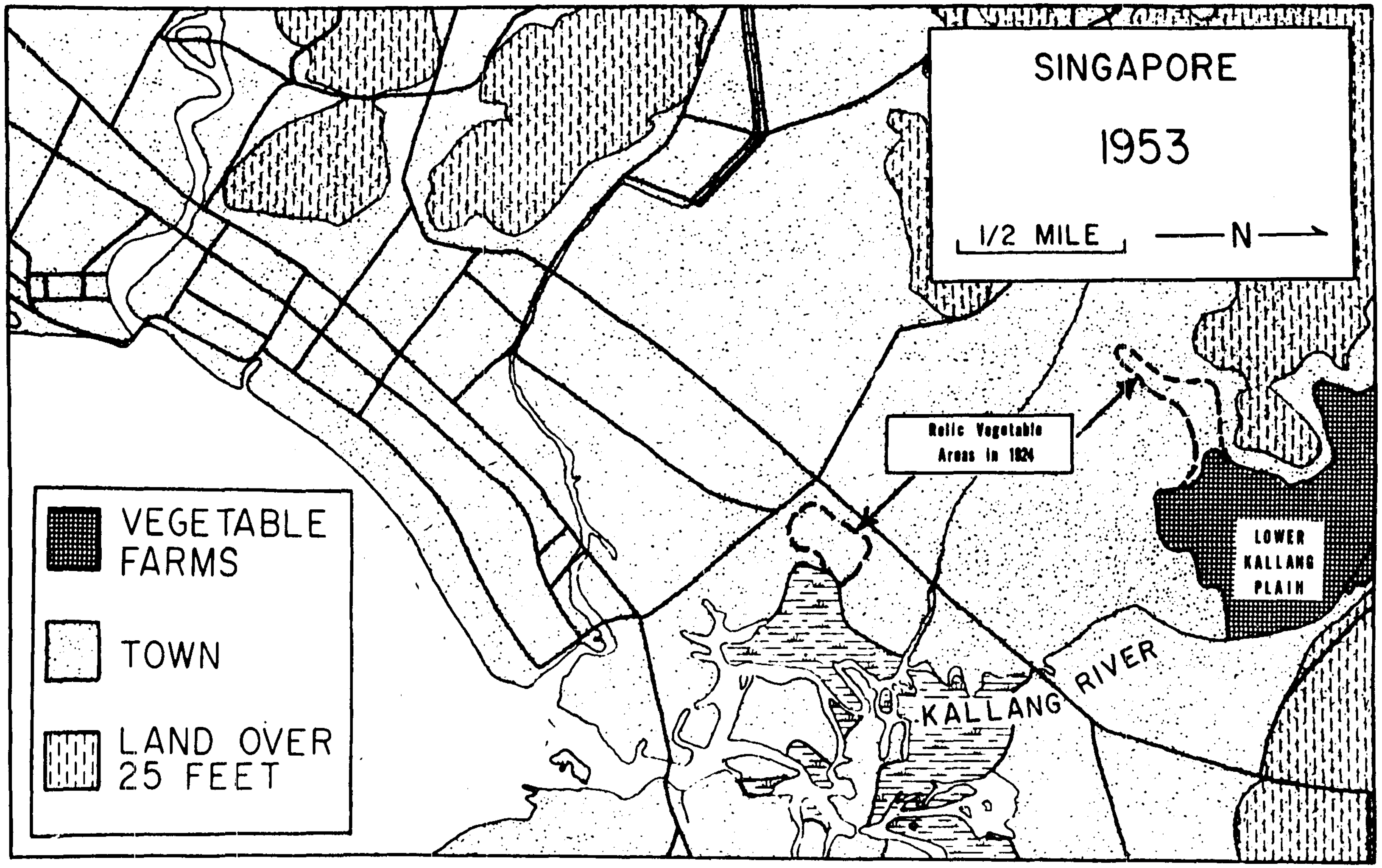
Raffles took formal possession of Singapore Island on January 28th, 1819. Two weeks later he was able to report that "the industrious Chinese are already established in the interior and may soon be expected to supply vegetables etc. equal to the demand" (quoted in Siang 1923:602). The population of the island was around 150 when Raffles landed in 1819. In five years it had risen to over 10,000. By 1820 the value of trade for the new port exceeded that for the well-established port of Malacca. In a word, Singapore was a boom town from the very start.

Raffles had been correct in predicting that Chinese would soon be producing vegetables for the new town: In a letter of instructions written to the town committee by Raffles in 1822, he advised that it might be necessary to exclude Chinese cultivators from the area to be occupied by the town as it was then being planned, and he referred to the existence then of a vegetable market (Buckley 1902:I,76). Before 1830 the authorities removed from the town area "a number of Chinese who had formed vegetable gardens on the plain, within the limits of the town, part of which is now...Bencoolen Village" (Singapore Free Press, Dec. 17, 1835:2; see also Siang 1923:602). Bencoolen village occupied an area now nearly in the center of the city, on the alluvial, and probably at that time swampy, plain between the Singapore and Rochore rivers. At that time it lay roughly on the northern edge of the town.

A land-use map by G. D. Coleman of the environs of the young town as it appeared in the middle 1830's (Moor 1837: frontispiece; see also Wheatley 1954:63-66) provides us with data on the distribution of vegetable farming at that time (see Map 8). The town had grown northward to the Rochore River, its northern end lying roughly at the point on the coast where the Rochore and Kallang rivers empty into Singapore harbor. Inland from this point lay an area of swampy lowland, in places occupied by brick kilns. About a half mile from the shore, in a zone roughly parallel to it and stretching from north of the Rochore to the Kallang, lay vegetable gardens. Unfortunately, the map does not indicate how far along or beyond the Kallang this zone extended, so we cannot judge its actual extent, nor indicate on Map 8 the exact limits. It is reasonably certain, however, that the vegetable farms occupied a portion of the "inner ring" about the town, and probable that north of it lay virgin swamp forest; to the northwest was (in 1837) an area, with which we shall be concerned shortly, being cleared by Balestier for sugar planting. Coleman's map shows no other area designated as "vegetable gardens:" Southwest of the town lay the "rough ground" of Mt. Faber and Tanjong Pagar; to the west lay pepper, gambir, and forest. Low-lying land immediately to the northwest of the town, and adjoining the vegetable gardens, was devoted to padi and sireh. (The padi area was ephemeral, as was, in all probability, the sireh.) At this time the vegetable gardens were, as in the preceding decade, on the outskirts of the town, and on low-lying, clay-soil, alluvial land. They had migrated northward perhaps a mile and a half from the presumed original site toward the present site. Balestier's sugar plantation occupied an area which is today



Map 8. Singapore in 1836, showing the vegetable-gardening area adjoining the town's margin. At this time the Lower Kallang Plain was probably swamp forest; Balestier Plain was being cleared for sugar. (Source: map by Coleman, reprinted in Buckley 1901.)



Map 9. Singapore in 1953. The vegetable-gardening area has retreated up into the Lower Kallang Plain, although it still adjoins the metropolitan area. Note the farming areas which were present in 1924 and have disappeared since. The southernmost of these lies within the area occupied by vegetable gardens in 1836. (Sources of base map: topographic maps of Singapore, 1924 and 1945.)

partly urbanized and partly under vegetables.

Thus, within a decade of the colony's founding, a zone of vegetable gardens existed on the same alluvial plain, in roughly the same position in relation to the town, as it does today. Since a positional change from the original site to one intermediate between it and the present site occurred before 1837, we can infer a migration outward, along the edge of the expanding city, to the present site.

However, we have no information on the crops produced in this area during the first century. Nor do we have documents providing an explanation for the position of the vegetable-producing area during any phase of its existence. We can, however, suggest probable answers to both questions, arguing by inference from the contemporary functional situation, from the historical analysis already presented, and from some peripheral statements found in 19th-century sources.

T. Oxley, in 1836, provides the first known vegetable crop list for Singapore in the following rather picturesque account:

> In walking through our markets it is enough to give one a fit of dyspepsia to see the tough and wretched production exhibited in our stalls. The rank loba or native radish, the stringy kidney bean, the coarse sesawee or mustard, make one ready to cry out oh!...such unassimilating rubbish (T. Oxley 1836).

Five years later Col. Low's journal added additional crops: sweet potatoes, "bad yams," keladi (taro), and "inferior sorts of cabbages" (Wheatley 1954:66). Wilkes, who visited the island in about the same year, added lettuce and garlic to the list (Wilkes 1845:392). And in 1850 V. P. Oxley provided a long list, including "the only sorts" of vegetables to be found in the market: French bean, mustard, egg plant (= brinjal), lady's finger (a gourd), loofah (another gourd), "two or three species of cucurbita," "a good spinnage," yams, sweet potatoes (which "are in abundance"), "one or two species of arum called keladie" (taro; perhaps also Xanthosoma taro), and "some inferior onions and coarse greens" (Oxley 1850:439). And finally, in 1877 -- there would be no point in adding crop lists given at later dates than this, since our concern is with the earliest decades -- Burbidge lists the following vegetables to be had in the market: "Chinese long beans," "green lettuces," "young onions" (= spring onion or choong), tomatoes, and "one hundred others" (Burbidge 1880:16).

By Burbidge's time (1880), vegetable gardening had become "a monopoly of the thrifty Chinese gardeners" (16). But whether or not Chinese dominated the industry before then remains to be proven. Coleman's map for 1836 shows the alluvial area between the Rochore and Kallang as being occupied in part by Chinese vegetable gardeners. However, according to Low, in the early days both Chinese and Malays provided vegetables for the Singapore market (Buckley 1902:361).

Certain inferences as to whether the farmers were Chinese can be drawn from the crops listed above. The mustard referred to by T. Oxley in 1836 and V. P. Oxley in 1850, lettuce, the cabbages referred to by Low and by V. P. Oxley, the taro, which, according to Low (in Buckley 1902:361) "is cultivated in swampy places," and possibly the sweet potato, were probably moist-soil crops of the Kallang alluvial area. The beans, cucumbers, gourds, yams, and other dry-soil crops may have been grown on uplands, perhaps in association with pepper and gambier. However, long beans, lady's finger, and several other dry-soil crops are grown today in the Lower Kallang Plain under special management conditions, and where a somewhat sandier soil is used. Further, most of the crops mentioned by the various authors seem rather to be Chinese than Malaysian. Taro, or keladi, which might be thought an exception in consequence of its Malaysian name and its origin, is common in Hong Kong, where several varieties are grown (Herklots 1947:182), and in Foochow, where four varieties are described by Skvortzow (1920:138). The stalks and leaves were sold as pig feed in Singapore (Low, quoted in Buckley 1902:361). Thus taro, too, would appear to have been a Chinese crop of the time. Another telling argument for this view is that every crop mentioned above is listed by Herklots (1947) as being grown in Hong Kong, while many are not mentioned as Malaysian crops by Ochse in his monumental Vegetables of the Dutch East Indies (1931).

Unfortunately, we have no direct way of determining whether Cantonese, Hokkiens, Teochius, or all three together, were the vegetable gardeners in the early Rochore-Kallang alluvial plain. The similarity of the present farming system to Pearl River delta farming has already been mentioned (Chapter X). But we have discovered no specific instance of a pattern or crop found today or in the past in the Kallang area about which it can be positively stated that it is Cantonese rather than Fukienese in its area of origin.

Much of what later became a leaf-stem vegetable area was initially -- perhaps starting about 1830 -- in sugar. Balestier, and later Montgomerie, had estates in the area, Balestier's occupying the inner portion of the plain and Montgomerie's lying farther up the plain and away from the town. The system was rather one of cane-farming than large-scale unitary production: Chinese contractors grew the cane; Balestier and Montgomerie undertook only the transporting of the cane and the grinding and later operations (Singapore Free Press Oct. 3, 1844). Were we able to determine that Cantonese were the contractors, we should be well on the way to solving the problem. Just possibly the indentured Hokkien and Teochiu immigrants were diverted to Hokkien enterprises, while Cantonese became unskilled laborers in such enterprises as Balestier's and Montgomerie's estates, but we have no evidence that this was, in fact, the case. (Wilkes remarks that Balestier employed 150 Madrasi laborers. Wilkes 1845: 389.)

The final question concerning origins with which we must deal involves an explanation for the original location of Chinese vegetable gardens in the alluvial area between the Rochore and Kallang rivers. Fortunately, some evidence does exist on this point. In the earliest days the uplands about the town were being developed by pepper, gambir, and nutmeg planters; later, although to a certain extent during the same period, Europeans were building homes on these same hills. These facts would suggest that little land was available for the vegetable gardener, were it not for the fact, discussed in the preceding chapter, that vegetables were grown as a supplementary enterprise on the Chinese pepper and gambir plantations. However, a number of the crops mentioned by T. Oxley must be assigned to a lowland area; among these are mustard, taro (as it was grown in Singapore), and lettuce, and perhaps also cabbage, sweet potatoes, and spring onions. Further, the process of land development was taking quite a different course, one more suited to vegetable gardening, in the lowlands to the north. None of the valuable crops was suited to this heavy, blue clay soil, subject to serious waterlogging. Thus it comes as no surprise when we read, in the Singapore Free Press for Oct. 8, 1835, a description of this area as being "well wooded where the axe and fire have not prepared it for the numerous Chinese gardeners who have settled in the extensive tract between the town and the river Callan [Kallang]; but beyond that stream there are but few cuttings in the jungle," the soil here being "composed of clay and alluvial deposits." While sireh and rice were also grown in this general area, neither was a particularly valuable crop; and sireh -- in contrast to P. nigrum -- is, along with rice, a wetland crop, both perhaps occupying at that time land which could not as yet be drained adequately for vegetable production.

The peculiar advantage which the bluish grey soils of this area possessed, or rather were provided with through the application of traditional Chinese gardening methods, was their suitability for production of different vegetable types requiring varying crop-ecological conditions. A farmer here could grow flooded crops (rice, water-cress, Ipomoea reptans) alongside the raised beds of green vegetables. Probably most, if not all, dry-soil crops could be planted in the same area so long as root-drowning was avoided through ridging; these crops differ in ecology from the leaf-stem vegetables largely in water and air relations, the latter requiring hand watering. Thus, the lowlands could, perhaps, supply essentially all vegetable needs of the town on a area providing ample room for expansion, whereas the uplands were limited both in crops and in area.[1] It should be noted that two other lowland areas were available for cultivation, these being the Geylang plain and the zone inland from the city along the Singapore River. Both, however, seem to have been too wet for easy reclamation, and the latter probably somewhat sandier; the latter was also farther from town and the former smaller in extent than the one chosen by farmers.

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[1]Bennett (1834 II:132) remarks that some of the vegetables consumed in Singapore were imported from Malacca and the neighboring islands. This would have applied only to dry-soil vegetables, most of which were at least moderately storable. If his observations were correct our inference that the lowlands supplied dry-soil as well as moist-soil vegetables is open to question. However, they would reinforce the argument that uplands contributed little to the town markets at that time. In any case, Moor (1837:244), in a list of imports from Malacca, does not include vegetables.

Emerging Modern Patterns.--A map published by Thomson in 1846 shows a pattern of vegetable cultivation rather similar to that which pertained at the time of Coleman's survey in the early 1830's: Vegetable cultivation still occupied the area coastward from Serangoon Road, and north almost to the Kallang Plain -- which at that time was occupied by a sugar plantation. In addition, a new vegetable area had been developed to the west of Balestier's estate, between the present Bukit Timah and Balestier roads. Thus vegetable cultivation had survived along the margins of the two important sugar estates of the island, still occupying low-lying, clayey alluvial land.

In 1849 Balestier's plantation failed, and was put up for sale. The advertisement appearing in the Free Press for March 15th of that year describes the estate as having drainage and irrigation ditches which communicated with a canal two miles long, one broad and deep enough to be used for cane transport. The second estate (Montgomerie had sold it in or before 1843), which extended into the Kallang Plain, was still in operation, but apparently failed a few years later. The pattern of ditches visible in the Kallang Plain today (see Plate I, an air photo of the plain) resembles a layout of once-interconnected drains such as might have been developed for a sugar estate; the advertisement referred to suggests, in view of the similarity between the two adjoining areas, that such drains did exist at the time in the plain.

The period between the 1850's and 1920's is almost devoid of references to leaf-stem vegetable cultivation, and our attempt to trace the probable pattern of change during these 70-odd years must again depend on inferences. Since there seems to have been only one crop -- pineapples -- competing with vegetables in the original area after sugar left, and since the drainage undertaken by Balestier and Montgomerie very probably enhanced the value which the plain possessed for vegetables, it would appear that either vegetable or pineapple cultivation came into this zone during the third quarter of the century. Pineapples were important up to about 1880; after that the area planted to this crop seems to have declined. A map of the town area published in 1898 (Royal Asiatic Society, Straits Branch) gives some evidence that both the original vegetable area (east of Serangoon Road) and part of what had been Balestier's plain (west of the road) were under vegetables; the Kallang area is not shown. But for our purposes the most important bit of evidence is provided in a map published much later, in 1924 (Straits Settlements, Surveyor General). This detailed topographic map (covering the island at a scale of four inches to the mile in fifteen sheets) shows vegetable cultivation still remaining in a portion of the area east of Serangoon Road, at the very edge of the urbanized zone, and in a sizeable part of Balestier's old estate. Further, it shows vegetable cultivation sharing the Lower Kallang Plain with rubber. The year 1924 puts us within the period for which Kallang farmers of 1952 can supply information from memory: Many recall having moved -- or their fathers having moved -- from the two inner areas, which are now built up, to the plain, and the tie-in between past and present would appear to be complete.

However, one serious problem still remains. We know that the rubber craze of the second and third decade of this century forced out many vegetable cultivators (cf. Makepeace 1921: I, 314). We do not in addition know the patterns of land tenure which prevailed throughout the Kallang Plain, and therefore the likelihood that vegetable cultivation persisted during the period when rubber planters and speculators were buying up all land that could be obtained, almost irrespective of its quality. The likelihood seems to be that the central and northern portion of the plain remained in vegetables: They are Crown land today, and probably were that forty years ago. The southern portion of the lower plain is shown on the 1924 map as being partly planted to rubber and partly to vegetables; very likely the vegetables were absent from this part of the plain five or ten years earlier. Makepeace (ibid.), in describing the official concern over the "disappearance of the small...vegetable cultivator from many parts of the island" refers to the considerable increase (around 1920) in a form of tenure on Crown land known as "Temporary Occupation Permits." These permits, designed to limit use of a piece of land to food producers, are still operative in the Kallang Plain: It seems probable that this mechanism succeeded in saving the farms in the area from the encroachment of rubber.

To summarize: We have concrete evidence that the Lower

Kallang Plain and contiguous areas lying roughly to the south have formed a continuous zone of leaf-stem vegetable production, always located close to the urban fringe, since the earliest years of Singapore. We do not know whether the area has been Cantonese since it first developed, although we have some historical evidence in support of this hypothesis, no evidence against it, and the rather telling argument that a Cantonese-settled area today seems unlikely to have been anyting else since the first years of Chinese settlement.

Areal Expansion in the Twentieth Century.--Finally, it remains for us to examine the pattern of areal spread of leaf-stem vegetable farming, from the initial Kallang site to the many small groups of farms of this type found in widely separated parts of the island today. The few maps of the island for the late 19th and early 20th centuries provide some evidence, but perhaps the most important is supplied in the periodic censuses of the island's population.

Except for roads to Changi and Kranji, no main access roads crossed the island up to the last quarter of the 19th century. However, by 1898, the year in which the first of these maps appeared (a map of the island reproduced in Buckley: II, frontispiece), all of the present-day main roads of the island with the exception only of Jurong and Lim Chu Kang roads had been put in. Whether or not leaf-stem vegetable cultivation took place along or near these roads in the interior cannot be determined from the map. By 1911 (Great Britain, War Office, one inch to the mile) Jurong Road had reached a point beyond Ulu Pandan, a small but important leaf-stem vegetable area today. Thus nearly all of the present producing areas were moderately accessible to roads by that time, the principal exception having been Lokyang and the scattered group of farms of this type to the southwest of this village. Again, no data on farming are provided in this map.

It seems unlikely, in spite of the physical expansion of access roads during this period, that the outer areas of present-day leaf-stem vegetable production, (shown on Map 1, in pocket) were producing these crops before 1900 at the earliest. First of all, the Chinese population of Singapore in 1881 was one-tenth what it is today; yet today over half the Singapore production remains in the Kallang area. In other words, the Kallang area and vicinity, at least up to the time of rubber, could, we believe, have supplied the market fully. Secondly, no rapid means of bringing in perishable vegetables existed before 1903, when the railroad from Kranji (and later Johore) was laid down. (Tai Seng and the Kallang Plain alone were close enough to town to allow easy marketing of leaf-stem vegetables.) Granted, a farmer could have travelled by night from most parts of the island and perhaps managed to bring his crop in before dawn; but the likelihood of this happening on a systematic basis in a farming system yielding marketable produce from each farm nearly every day is slight.

By 1911 the Chinese population had risen to 220,000, not quite one-fourth of what it is today. In view of the fact that one-third (by very rough estimate) of the leaf-stem vegetables consumed in Singapore now are brought over from Johore, the ratio of Kallang production to total consumption thus becoming something like one to three or one to four, it is not unlikely that this area began to suffer competition from others about this time. Since our calculations are very approximate, we might suggest the period 1905-1920 as the time of expansion.

But the decade following 1910, it will be recalled, saw the astonishing expansion of rubber, and a parallel contraction of vegetable acreage, including the Kallang Plain. Probably this decade was the one in which significant areal spread began to take place: Farmers from part of the Kallang and Rochore area may have been forced to move out into the island, occupying small segments of land untouched by the rubber interests; wet lowland would be the last land these latter would seek. Further, the increased price of vegetables which resulted may have encouraged others (including Hokkiens and Teochius?) to take up cultivation, again at occasional spots in the interior; and, finally there may have been a shift toward the higher-value leaf-stem vegetables on the pre-existing Hokkien and Teochiu farms in the interior. These small areas of vegetable cultivation may very well have become the nuclei for expansion into the present important producing areas, and the significant role played by Hokkien and Teochiu farmers in the system today may be traceable to this time and process. That some expansion had taken place by 1924, which was about the time when rubber expansion ceased and wet lowlands went out of rubber production, is proven by the 1924 topographic series (Straits Settlements, Surveyor General 1924, four inches to the mile, fifteen sheets), which shows vegetable cultivation in the now-important Ulu Pandan area, and scattered farms along water courses in the Mandai area -- which today has leaf-stem vegetable farms along the same water courses and producing rubber between.

Unfortunately, the field work on which this essay is largely based was too limited in time and resources to allow interviewing of leaf-stem vegetable farmers outside of the Kallang Plain at the level of detail needed to establish family histories. Had these data been obtained, we should probably have been able to pin-point the dates on which the newer producing areas in the interior were started.

With regard to the numerical superiority which Hokkien and Teochiu farmers together enjoy over Cantonese in this farming system, one further possibility must be considered -- though briefly, for lack of strong evidence either supporting or refuting it. Hokkiens and Teochius who had developed farms on soil suitable for leaf-stem vegetable production, i.e., intermediate to heavy soil types on flat or very gently sloping land, may have shifted to this farming system from the dry-soil vegetable system. This would have been facilitated by a short- or long-term rise in the price of leaf-stem vegetables relative to that of the fruit-earth vegetables we associate with Hokkien-Teochiu farms in Singapore. Since diffusion of Cantonese traits should pose no serious problem in the small island, this possibility seems a reasonable one for explaining the intrusion of Hokkien-Teochiu farmers into the leaf-stem vegetable system. A variant of this hypothesis would have Hokkien-Teochiu farmers driven, with the rise of rubber planting, from the preferred uplands to wetter lowlands, where ecological conditions favored leaf-stem vegetables, diffusion again providing the needed technology.

Two bodies of evidence support the hypothesis that Hokkien-Teochiu farmers in some instances shifted from fruit-earth to leaf-stem vegetable production. Surveyed leaf-stem vegetable farms whose cultivated area is either gently sloping or both flat and sloping are operated almost entirely by Hokkiens and Teochius -- 90 per cent of these surveyed farmers speak this dialect. On the other hand, surveyed leaf-stem vegetable farms developed entirely on flat land have a ratio of three to two in favor of Cantonese, this preponderance of Cantonese becoming more striking when we consider the ratio of the numbers of farmers speaking the two dialects in the farming population as a whole. Thus there is clearly a heavy tendency for Cantonese leaf-stem vegetable farmers to occupy flat land, and even more for Hokkien-Teochius to occupy sloping land. While this correlation can be explained in terms of simple preference as regards land type, it seems far more reasonable to postulate a preference as regards total farming system, leaf-stem as against fruit-earth vegetable crop types and their associated practices. But the Cantonese farmer would not shun slopelands unless he distinctly preferred leaf-stem vegetable farming over the alternative, nor would Hokkien-Teochius, presumably, concentrate on slopelands -- which are ecologically less suited to leaf-stem vegetable production, on the whole-- unless his tastes ran toward the fruit-earth vegetable system, with leaf-stem vegetables forming a secondary enterprise, and later, perhaps, expanding to the major enterprise as a result of newly acquired techniques, price changes, and the like.

This point receives additional support from an analysis of the dialect data for farmers operating both vegetable enterprises: On surveyed farms, less than one-fifth of the farmers possessing <u>both</u> leaf-stem and fruit-earth vegetable crops in significant quantity were Cantonese. This may simply reflect the fact that most such combined-type farms are on either gently sloping or flat and gently sloping land, thus suggesting that land suited to both types could be found on the farm. But fully one-third of Hokkien-Teochiu leaf-stem vegetable farmers possess this combination of both vegetable enterprises while the proportion of all such Cantonese possessing both is much lower (roughly 11 per cent). Therefore, it appears reasonable to suppose that the leaf-stem vegetable system is distinctly Cantonese, and the Hokkien-Teochiu farmers have taken it up only under pressures of one sort or another, or where they possessed land far more suited to this system than the dry-soil system, and, in one-third of the cases, as a secondary enterprise on portions of the farm more suited (in terms of net income potential) to leaf-stem vegetables.

PART IV: THE LEAF-STEM VEGETABLE FARMING SYSTEM IN THE LOWER KALLANG PLAIN: ELEMENTS OF STRUCTURE AND PROCESS

CHAPTER XII

DISTRIBUTIONAL PATTERNS

The Lower Kallang Plain and its Significance.--Up to this point the discussion has dealt with theory, methodology, and, so far as substantive material is concerned, the setting of present-day leaf-stem vegetable cultivation in Singapore. We have concerned ourselves with the origin and evolution of the leaf-stem vegetable farming system, thus providing a means of understanding, in the broad sense, its present character. We have dealt also with the gross cultural and environmental factors which relate to the system in various ways.

We now turn to a consideration of the detailed characteristics of the system in the island. For reasons outlined in the following paragraphs, the approach used in this study involves microgeographic analysis of the single most important leaf-stem vegetable farming area, the Lower Kallang Plain, rather than a more generalized and less intensive analysis of all farms in the island.

As can be seen from Map 1 (in pocket), there are six general regions of leaf-stem vegetable cultivation in Singapore. In terms of area, number of farms, and production the Lower Kallang Plain is far more important than any of the others. This region possesses a number of characteristics which justify our dealing with it in considerable detail.

Assuming that there are about 600 leaf-stem vegetable farms in Singapore,[1] the 170 farms of this area account for roughly 30 per cent of the total. If we add the 36 additional leaf-stem vegetable farms found in the transitional Middle Kallang Plain, the percentage rises above one-third. Very likely, the proportion of total domestic production of leaf-stem vegetables coming from the Kallang Plain is much greater: It has an unusually well-controlled water supply, is closer to urban markets than other competing areas, and is more highly specialized in favor of the leaf-stem vegetable enterprise than are most.[2] Adding to the foregoing the fact that the area is almost certainly the direct descendant of the island's first leaf-stem vegetable producing area (portions of the estuarine plain below the present area and now urbanized), it becomes apparent that the Lower Kallang Plain is of considerable significance. No other area of this type approaches it either in numbers of farms or production.

The Lower Kallang Plain is one of the most curious farming

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[1]This figure is based on extrapolation from the 502 farms of this type which were surveyed. A rough estimate was made of the number of unsurveyed farms, on the basis of air-photo analysis and land-type on which the farms observed on photos were found.

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[2]The Agricultural Department estimated in 1952 that the Kallang area provided about two-thirds of the island's total production of leaf-stem vegetables. This figure may be slightly high; let us suggest one-half as a reasonable estimate.

regions in the tropics, possibly in the world as a whole. Among its more unusual traits we may mention population density (nearly 8,000 per square mile for the quarter-square-mile area), yields (fifty-nine tons per acre per year for all crops), and size of farm (five-tenths of an acre on the average). For these reasons alone, quite apart from its significance for Singapore, we would be justified in concentrating heavily on it at the expense of other areas in the island. For an investigation designed initially to test certain ideas concerning cultural-geographic theory and research design, no other area could have been found which would have provided a more favorable site: The unique features of the Lower Kallang Plain begged explanatory analysis, both historical and functional, and such analysis was the principal initial goal of this research.

In one important respect the Lower Kallang Plain is unrepresentative of leaf-stem vegetable cultivation in Singapore. Municipal ordinances -- the area is almost entirely within the limits of the city -- forbid pig-rearing. Not only has this inhibited this enterprise in the area, although several pig sties remain, but the relative absence of pigs has resulted in a greater emphasis on purchased fertilizers than would have been the case otherwise. Very possibly, too, the average size of farms in the plain would have been greater had there been a need for land on which to grow pig feed, to house the stock, and to collect manure. And finally, yields might have been lower if the lesser dependence on purchased fertilizers had allowed a greater percentage of profit on sales, and thus required smaller total sales to provide the same family net income. (We are arguing here that the functional interdependence of the parts of this farming system requires a general warping of the system when one important process element is removed or added. Were this an argument from the general to the particular, we might fairly be accused of classical functionalism.)

However, the fact that alternative enterprises, notably pig-rearing, are of no significance in this area opens up certain opportunities for analysis which add to the utility of the area for our study. We are dealing here with a relatively "pure" form of the leaf-stem vegetable farming system, and thus can isolate essential process elements more easily than would have been possible otherwise. Further, comparative data for other areas, notable Lokyang (which represents one opposite pole of the system in many respects), lead us to conclude that the Lower Kallang Plain is, from a qualitative standpoint, moderately representative, in important process elements, of leaf-stem vegetable production in Singapore.

Structural Features of the Region as a Whole. -- From Map 1 it will be seen that the Lower Kallang Plain is almost entirely surrounded by urbanized and partly urbanized portions of the Singapore metropolitan area. The alluvial plain of the Kallang River opens out into the estuarine plain, on which much of the inner portion of the city stands, at a point shortly above the Serangoon Road bridge over the river. The zone between Serangoon Road and the approximate lower end of the plain is occupied by urban structures, industrial, commercial, and residential. The road runs roughly NE-SW at this point; beyond the bridge it bends slightly northward, almost parallelling the plain. In this area, between the bridge and the suburban district of Paya Lebar, it is again bordered on the western, Kallang, side by structures, largely devoted to residential uses. And finally, the eastern border of the Lower Kallang Plain fronts on a zone of low hills which is partly occupied by residential dwellings, many of them squatter's huts, and partly by lalang wasteland. Only to the north, where the plain becomes what we choose to designate somewhat arbitrarily as the "middle" Kallang plain, does the lower plain adjoin a distinctly rural landscape.[3] Thus, the Lower Kallang Plain persists as a rural peninsula penetrating deeply into the urban area itself. While we are not concerned with explaining this unusual areal pattern, it would seem to result from two related factors: first, recognition on the part of the government of the island that the lower plain is an important food-producing area, and designation of government-controlled land in the plain as a food-producing reserve, zoned as such; and second, the fact that the somewhat swampy land (except where it is drained for farming) of the privately

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[3]The E-W-running Braddell Road has been set as the boundary between the lower and middle portions of the plain. Reasons for selecting Braddell Road as the line of separation are related to the distinction between the specialized farms of the lower plain and the zone of transition which is found to the north of Braddell Road.

owned portion does not encourage rental values above those the farmers themselves can offer -- and these can rise somewhat above their present level without seriously hurting the occupying farms.

From a point not far below the dam of Pierce Reservoir, the Kallang River is a graded stream, flowing through a narrow, irregular floodplain, and joined by minor tributaries at various points along its course from the dam to Singapore Harbor. The floodplain alternately widens where tributaries join the river, then narrows between low bordering uplands on either side. Its widest point is reached in the vicinity of Braddell Road, where the floodplain of the river's major tributary (now in part a drainage canal) joins it from the west.

Between Braddell and Serangoon roads the plain is constricted by a low hill which obtrudes into the plain from the west. (See air photo, Plate I.) Below this zone it broadens and finally merges with the estuarine plain underlying much of the eastern portion of Singapore City. No natural line of demarcation appears to separate the estuarine and riverine plains. For our purposes the plain of the Kallang may be considered to terminate immediately above an irregular line of ponds which lie between the lower limits of the farming area and the urbanized zone along Serangoon Road. Since the ponds are artificial, the boundary is based exclusively on cultural, rather than natural considerations -- in fact, it seems certain that urban expansion rather than any natural break accounts for the position of the lower boundary of the farming area itself.

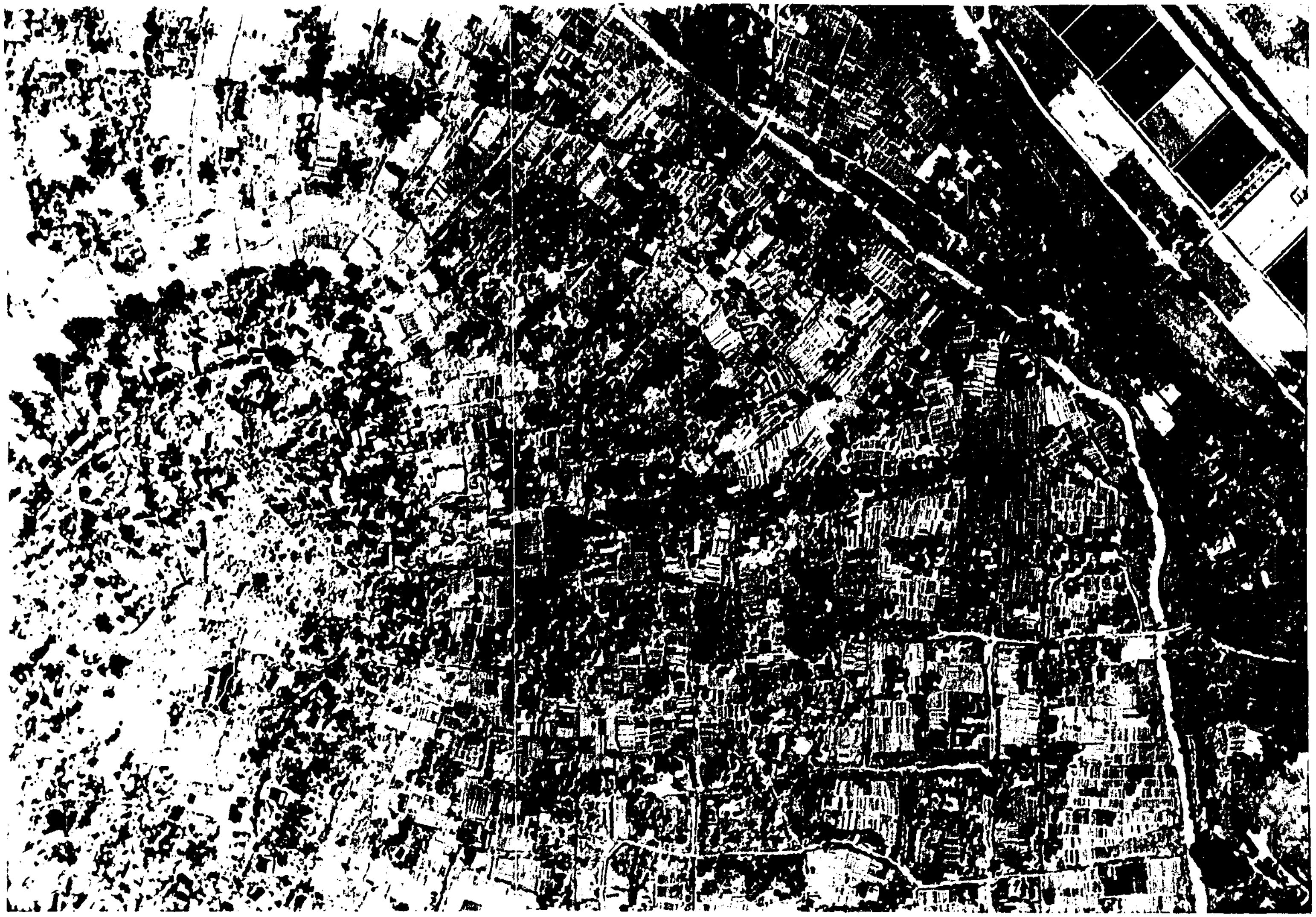

Plate I. Aerial photograph of the central portion of the Lower Kallang Plain. Scale approximately 1:4,350. The hill jutting into the plain on the left (west) is partly occupied by poor urban residences. At the upper right (northeast) are the Woodleigh filter beds. At lower right (southeast) is another zone of poor urban residences. Note the moderately dispersed settlement pattern and almost complete utilization of the plain surface. Subrectangular lines in the plain are drains and paths.

Throughout the lower plain no surface irregularities exist. There may be a small decrease in elevation westward from the river to the edge of the plain, but this is not certain: The only evidence for it is a lowering of the water table toward the river.

The over-all shape of the farming area below Braddell Road is roughly that of a rectangle, somewhat longer north-south than east-west, possessing a slight NW-SE tilt, and constricted slightly where a low hill protrudes into the plain from the west. (See Map 1.) Both the western and eastern sides are demarcated topographically, with slight rises in elevation and somewhat sandier soils indicating the margins. Throughout most of this portion of the plain the Kallang runs along the eastern margin; it crosses Braddell Road near the western edge of its alluvial plain, then shifts across to the eastern side. Thus nearly all farms in the plain lie either to the west of the river or, near Braddell Road, to the northeast. There are indications of earlier courses nearer the western margin; whether these were abandoned before the colony was founded, or whether a sugar-cane plantation drainage system diverted the river eastward during the nineteenth century is not known -- the regularity of the stream's course suggests the latter.

Surprisingly little functional differentiation occurs within the Lower Kallang Plain farming area itself. Farms tend to be similar in size range throughout, and, except for a slight increase in fruit-earth vegetable production along the western, wetter, margin, do not reveal subregional patterns in production. Further, no integrated network of roads covers the plain. One dry-weather track runs along the eastern side of the Kallang River; numerous footpaths criss-cross the plain in an irregular pattern, often parallelling drains. These latter form a poorly integrated net, the larger ones emptying into the river for the most part, the smaller ones either emptying into the larger ones or, more frequently, simply petering out; no single drainage complex thus exists for removing excess surface water after heavy or prolonged rains -- a point to which we will return in Chapter XVII. And finally, no distinct, nonagricultural hamlets are to be found in the farming area. One or two coffee shops, a Chinese temple and open stage, and occasional dwellings occupied by non-farming families occur; the only distinct assemblage of urban structures is found at one point on the eastern side of the river. Here coffee shops, retail shops, a temple, a stage, and other structures form a single urbanized cluster, Kampong Potong Pasir. In addition, other retail and coffee shops lie to the south of the area, approaching Serangoon Road.

Vegetable marketing routes leave the plain in at least three directions: westward along Braddell Road, southward to Serangoon Road, and southwestward toward Balestier Road. Most vegetables move to arterial roads and are carried to the center of town, at informal wholesale market areas along and near Hong Kong Street; from here they disperse, now in the hands of wholesalers, to the various retail vegetable markets. Farm supply, on the other hand, follows less definite routes. Some purchases are made in town, others in the Kallang district; generally, the amount involved at each purchase is small and the times of purchase irregular.

The actual area covered by the farming region can be given here in general terms, since the investigation dealt exclusively with the farms themselves and ignored unfarmed land within the region. Possibly the area amounts to about 120 acres, 86 of which are in farms. A total of 170 farms was found to be present, the average area of each farm being almost exactly a half acre. The area in crops or temporary (i.e., daily or weekly) fallow amounts to about 23 acres, or .14 acre -- 5,960 square feet -- per farm. However, the area of inter-bed paths (see below) should be added, raising the total cultivated area to 32 acres, and the average per farm to .19 acre.

Structural Features of the Farms. -- It would be well for us, at this point, to describe from a structural standpoint the occupance features characteristic of typical farms in the plain. The important features are: the farm houses; associated productive and nonproductive structures (pig sties, chicken coops, storage huts, and kitchens); vegetable beds and bordering paths; small clumps of fruit trees; farmyards and other small open spaces on farms; access paths; and ponds and drains.

The farms tend to be subrectangular in shape, deriving possibly from the shapes of units of land leased by the government on Temporary Occupance Licenses in the past, though now considerably subdivided. In part, also, the shape may derive from the vaguely rectangular pattern of minor drains, which may (and in some cases certainly do) antedate the farms themselves.

Vegetable beds are fairly uniform in pattern. Typically, they are three to four feet in width and from thirty to fifty feet long. They are normally arranged in blocks of from three or four to as much as twenty parallel beds. While the beds themselves are rectangular (though rounded somewhat at the ends), the blocks of beds may take any form, depending on the shape of the area a farmer chooses to put into vegetables. Between the beds are narrow paths, generally about a foot wide, and somewhat broader paths separate the blocks. Most beds are cambered, rising from about two or three inches above the paths along their edges to between six inches and a foot or more in the center. (In areas of somewhat lighter soil the beds were observed to be higher and to have a more flattened appearance, reflecting a relationship between the cross-sectional shape and the need for good surface drainage: The lighter soils, possessing better internal drainage, require less cambering.) The fully grown vegetables, most varieties of which possess broad leaves or a large volume of herbage, spread over the paths, providing almost complete vegetative ground cover.

Each farm either includes a pond within its boundaries or shares one with a neighboring farm; most have, or adjoin, two or more. These are perhaps four feet deep (varying with the depth of the water table, among other things) and are dug by hand. Spacing of the ponds is aimed at reducing to a minimum the distance between any one bed and a pond, since hand-watering depends on water collected in the ponds. They serve also as reservoirs for surface run-off, fed by the interbed paths which function as shallow drains during rains. Some of the ponds connect with the larger regional drains to provide a safety valve for excess rainwater.

The remaining features may be mentioned briefly. Farm houses, which will be described along with other productive structures in Chapter XV, average 1,015 square feet in area, and are rectangular. Open spaces rarely attain any areal importance, except on farms where much more cultivable land is available than can be handled by the family. On those farms possessing pig or poultry enterprises fairly large pens or poultry runs may be found; these are usually covered over by fruit trees to provide shade for the animals as well as a further source of real income. Although few have more than a handfull of fruit trees, the trees produce sufficient shade to provide vegetative ground cover over most of the uncultivated portions of the farms.

CHAPTER XIII

THE FARMERS AND FARM FAMILIES

Farming Population.--In the present chapter we will summarize briefly the salient facts on numbers of participants in Kallang farming, their origins, relationships, and statuses in relation to the regional labor force. The discussion will move freely between the macro-regional level of the Kallang farming area as a whole and the micro-regional level of the individual farm. Implications of the data as regards productive behavior and attitudes will be dealt with in subsequent chapters.

Drawing on data from 163 of the 170 farms, and extrapolating for the remainder, a figure of 1,123 individuals is arrived at for the total farming population of the Lower Kallang Plain. The mean population per farm is thus 6.6, and the modal farm has two adult males, two adult females, and three children dwelling on it.[1] (All figures refer to mid-1952.)

By simple division, the crude population density on farms is reckoned to be equivalent to 8,385 per square mile for the one-seventh of a square mile in farms. If this value can be

[1]An "adult" is defined here as an individual sixteen years old or more.

shown to be one for definitely rural population density, it reveals itself as quite an unusually high one. Neither the small total area covered nor the position of the region within the city limits need invalidate the figure. We must, however, ascertain that we are not including a large number of individuals who obtain their livelihood from outside the region, since these individuals would represent a population not purely dependent on the area itself, and would, in effect, enlarge the area inhabited by the same population, thus making the Kallang density figure itself unrealistically high. Further, we must ascertain that we are not dealing with a population which includes many individuals employed in non-farming income-producing activities, since such a population would be in part an urban one, and urban densities of the order of 8,000 per square mile are by no means unusual.

If we eliminate the 71 farms which report some non-farm income, usually derived from off-the-farm employment, the remainder of 99 farms still reveals a population density (per square mile of land in farms) of 7,927. (Data continue to be from 163 farms reporting, with extrapolation to the total population of 170 farms.) Few possible biases which might have warped the density value upward can be isolated. The only bias moving in this direction which seems reasonably expectable is non-reporting of off-the-farm employment or income. A likely bias in the opposite direction is the common tendency in the area to report fewer than the total household population, particularly (as in 1952) when the government had threatened conscription. The writer is inclined, therefore, to accept the range lying between 7,500 and 8,500 as including the correct value. This density appears to be in line with what we might expect in an area producing cash crops at as high a level of intensity as prevails in the Lower Kallang Plain.

Cultural Background. -- At the time the total-area survey of the Lower Kallang Plain took place it had not yet been decided to seek a cultural breakdown on the basis of dialect per se. Questions were asked of the farmers on their village and province of origin, the assumption having been made that data on these points would suffice, and, if a dialect breakdown were later needed, it could be obtained from these data. Unfortunately, the problem of locating Chinese places from ad hoc transliteration of the names by students in the field, added to the usual non-response ratio, resulted in satisfactory answers being obtained on these questions from only 59 per cent of the farms; had we simply asked the students to record the dialect in which the interview was carried out, the response would have approached completeness. However, the 101 farms providing usable data on farmer's origin revealed enough uniformity to allow generalization.

Eighty-six of the 101 farmers -- the questions referred exclusively to the farm operator himself -- came from Cantonese-speaking areas in China. The remaining 15 came from Teochiu and Hokkien areas, 11 from the former, 4 from the latter. The distribution of non-Cantonese in the Kallang Plain supports the hypothesis that the plain was initially an even more thoroughly Cantonese farming area than it is at present. The majority of non-Cantonese farmers are located on the periphery of the region, most of them in a part, along the southern margin, which the 1924 topographic map shows as having been under rubber, not vegetables, at that time. Further, leaf-stem vegetable farmers in the Middle Kallang Plain, which forms the northern peripheral zone for the region, are non-Cantonese in a ratio of eight to three; since settlement of the plain by small farmers almost certainly proceeded northward, this being the pattern of expansion recorded during the last century, this non-Cantonese area is one of later settlement than the lower plain. And finally, two non-leaf-stem vegetable farms along the western edge of the plain are among the very few Cantonese fruit-earth vegetable farms in the island.

Only 18 per cent of the Lower Kallang Plain farm operators were born in Singapore. As we pointed out in Chapter XI, this implies neither a recent origin for the system nor a recent transplant from China. It appears probable that most of the farmers have spent the majority of their lives in Singapore or Malaya.

The assumption that farming in Singapore is transient, characterised by impermanent farm occupance and high occupational mobility is not supported by the data obtained in this study. Our information on length of farm occupance indicates that period of residence is, on the whole, surprisingly long. In the Lower Kallang Plain over half the farms have been worked by present occupants since before the Japanese occupation -- the mean length is 14.4 years. Roughly 35 per cent have been occupied since 1932 or before, and, 12 per cent have been occupied for thirty years or longer. (Data are from 103 farms.) Although no information was sought from farmers on land use prior to their arrival, or on the question whether farms were first cultivated by present occupants or their predecessors, it is probably true that most farms have seen two or more successive occupants. Evidence for this includes the fact that about 15 per cent of ninety-three farms replying stated prior occupation of another farm in the Lower Kallang Plain (as well as an average length of occupance on the present farm of eighteen years), and the fact that a number of instances of turnover during 1951 and 1952, with prior occupance by other farmers, was encountered. The relative stability of occupance is rather noteworthy in view of the high occupational mobility and labor turnover in Colony industries in general, and the disrupting events of recent years.

<u>The Farm Labor Force</u>. -- Before we proceed to a discussion of the labor contributions of various participants in the farm labor force, certain terms and concepts will have to be clarified. The standard unit of labor will be the "man-day," defined as the time input of an average adult male participant during a single day of work on the farm. Since women predominate in

the labor force, and children add a significant, though minor, contribution, it will be necessary to include these contributions by converting female and child labor into standard man-day units, taking into account, so far as possible, both time and efficiency factors. For women, the time factor is affected by such things as household duties, and varies with the composition of the household. The efficiency factor is relevant only where a strenuous task normally performed by adult males falls to women because of the unavailability of male labor -- this, again, depending on household composition. Tasks normally performed by either women or men are not considered to be performed any less efficiently by women. For children under sixteen, the activity analysis described in Chapter XVI shows a time contribution equal to roughly 16 per cent of what might be obtained were all children old enough to work in the fields doing such work on a full-time basis. If we then assume efficiency equal to 50 per cent of adult males, we can roughly value child labor at 8 per cent of adult male labor per day. Since both male and female adult labor vary with a number of factors, it would be best if we illustrated the calculations employed here with a number of types of situations.

Case 1: A man working full-time on a farm all year is given a labor value of one man-year or 365 man-days. (A seven-day week seems to be modal.)

Case 2: A man working off the farm during part or all of a year is given a value in man-days per year equal to 365 man-days less the number of days of off-the-farm employment.

<u>Case 3</u>: A woman alone on a farm with neither men nor children is given a value of 3/4 of a man-day per day, on the assumtion that the time contribution is equal to that of male full-time workers, that half the tasks are performed as efficiently as by men, and that the remainder -- such heavy tasks as hand-watering and tilling -- are performed at 50 per cent efficiency.

<u>Case 4</u>: A woman on a farm with children but no men is given a value of 3/4 man-days per day, since the added housework can be assumed to balance, very approximately, the added contribution of the farm children.

<u>Case 5</u>: Women on farms with men, up to a number of women below or equal to the number of men working full-time on the farm, are given a labor value of 1/2 man-day per day. Here men perform the heavy operations, and efficiency of women is therefore equal to that of men; however, an estimated half of the working day (mornings to 10 or 11, middays) is spent in household duties.

<u>Case 6</u>: Additional women, above a number equal to that of men, are assumed to have little housework -- or, what amounts to the same thing for the farm as a whole, share the work with women coming under the preceding case -- and are therefore given a value of 3/4 man-days per day.

Other cases less frequently encountered are dealt with similarly, and minor adjustments are made where necessary.

Admittedly, some of the conversions are rather arbitrary, but they represent the best possible approximations in the light of available data, and are justified by the need for standard units of labor.

We must also distinguish between "available" labor and "actual" labor for each farm. The former represents the number of man-days per year potentially employable at farm labor, i.e., the number of man-days which would have been employed at such work if no members of the family worked off the farm during the year. "Actual" labor is the calculated labor expended, or available labor plus hired labor less the number of days of non-farm employment. And finally, the term "family labor" as used here, in contrast to farm-management usage, includes the labor of the farm operator; we shall point out in Chapter XIX why the conventional distinction between the labor contribution of the farm operator and that of his family cannot be employed in this study, or, indeed, in many studies dealing with non-western peasant economies.

The total available family labor on all farms in the region amounts (as of mid-1952) to 476 man-years, on the basis of a 365-man-day year.[2] The average per farm is thus 2.8 man-years (1,020 man-days) per farm per year. Actual family labor totals 387 man-years, an average of 2.3 man-years (830 man-days) per farm per year. Values for actual family labor per farm ranged from a low of 263 man-days (274 for farms with no outside employment) to 2691 man-days.

On an estimated 71 farms one or more members of the family, or dwelling unit, work part-time or full-time off the farm,

[2]All values given in this chapter are extrapolations from data for 144-163 farms.

usually in the city. The total number of man-days of non-farm employment is estimated to be 32,300 or 104 312-day man-years, (88 365-day man-years) per year. The mean number of man-days of non-farm employment is thus 460 (1.5 312-day man-years) per farm per year for those farms with one or more persons employed off the farm, and 190 (0.6 312-day man-years) for all farms. (Data are from 144 farms.)

Excluding one doubtful case -- a six-acre farm with a large but undisclosed amount of hired labor -- the total number of man-days reported for hired labor during the year is 711. Only 17 farms, out of 146 providing satisfactory answers to this question, reported the use of hired labor. Three of these stated "a few" man-days; the remaining 14 farms used from two to 312 man-days, with a mean of 51. The total number of man-days for the 170 farms in the region is probably between 800 and 850 for the year, although an exact figure cannot be provided. It is clear, however, that hired labor is of no significance, since it accounts for only a fraction of one per cent of actual farm labor. Most farms using hired labor found it profitable to do so only at odd intervals.

The total actual labor on farms in the region, including both family and hired labor, thus amounts to about 389 man-years per year, or an average of 835 man-days per farm per year. This may be compared with acreage to yield "labor density" (or labor intensity) values which are rather illuminating. The total labor input per acre in farms is 1,670 man-days, or 4.6 man-years per year. The input per cultivated acre amounts to 6,095 man-days, or 16.7 man-years, per year. (For purposes of comparison with farming areas where a 6-day week is common, the number of man-years on a 312-day basis may be given: 19.5 per cultivated acre per year.) Assuming a nine-hour day, we obtain a value of about one hour and a quarter of labor per square foot per year. Since 365 nine-hour days per man-year is somewhat unrealistic -- festivals, sickness, and other circumstances, diminish productive days and hours -- we might lower the total to a seven-hour day; the input still remains at about one hour per square foot per year.[3] This is a rather graphic illustration of the meaning of gartenbau.

The number of farm dwellers who work in town amount to about 42 per cent of the number of adult males on farms and 5 per cent of adult females, with 71 of the 170 farms having one or more members employed elsewhere, and with 26 of the 170 having all adult males working off the farm. While this degree of emphasis on off-the-farm employment may seem high, it should be borne in mind that the region is physically closer to much urban employment than are many other areas within the city limits. In view of this accessibility to the urban labor market, the emphasis is seen to be surprisingly low, suggesting a successful, and long-continuing, resistance to forces which would tend to absorb the region into the city.

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[3]The activity cycle analysis (see Chapter XVI) suggests that men put in about 8 hours a day, women put in about 6½ hours, and children (very roughly) 2½ hours, on weekdays. Lower values for Sundays are unlikely, since part-time workers are then available.

CHAPTER XIV

CROPS AND LIVESTOCK: KINDS AND QUANTITIES

<u>Ground Crops</u>. -- The estimated total production of ground crops of all types in the Lower Kallang Plain amounted to 2,028,700 <u>katis</u>, or 1,350 tons, in the one-year period ending about July 1, 1952. Of this total, an estimated 1,938,800 <u>katis</u>, or 1,290 tons, were sold. The remainder, approximately sixty tons, was consumed or fed to stock. (Although figures for consumption are unreliable, it is clear that in the neighborhood of 95-96 per cent (by weight) of total production was sold.)

Figures given for crop production and yield rates should be interpreted with caution. Production and yield-rate data are subject to the following major types of error in this study: (1) Since they refer to a single year, 1951-52, they need not represent normal conditions or long-term averages. (2) Since the number of harvests per bed per year is high and most farmers stated average production figures per bed per harvest rather than annual totals, most such estimates, though honest, are highly approximate. Errors of this type tend to cancel each other out in a survey of this sort, where many farms of one basic type are included and nearly all farms in a region have been interviewed. However, there may well be a slight bias, again due to the frequency of harvests, in favour of production rates in the recent, as opposed to distant, past--i.e., in favour of early 1952 rates rather than average rates for the year. (3) Yields per square foot for the minor crops are subject to a serious error due to the fact that the area planted to such crops may fluctuate considerably, and certainly does to at least a minor degree, through the year. Any significant change in total area planted would upset to one degree or another our calculations of yield rates if the June-July, 1952, area is not the average for the year, taking the Lower Kallang Plain as a whole. It is not anticipated that Choy Sam, Pak Choy, Sai Yung Choy (?), and Kai Lan will be markedly subject to this source of error, since these enjoy high demand and since moderate fluctuations in production operate through variations in fertilizer application rate rather than increases or decreases in the number of beds planted to each. Further, it should be pointed out that total cultivated area does not fluctuate significantly, and decreases in the area planted to some crops are about counterbalanced by increases in the area planted to others. (4) Finally, the most serious source of error for all crops other than Choy Sam, but particularly for minor crops, results from the variable response ratio in interviews. Direct production reports cover only 74 per cent of estimated total production; direct area measurement covers only 87 per cent of total area; and direct yield-per-square-foot calculation--possible only when both production and area are given--covers only 63 per cent of the total possible. Reliability is high for Choy Sam, adequate for Kai

Lan, Pak Choy, Sai Yung Choy, Yin Choy, and Chung, and uncertain--the degree of uncertainty varying inversely with the number of reports and area per crop--for the remainder (which account for only 6½ per cent of estimated total production).

All production and sales figures apply to the one-year period preceding the field period in this area (mid-June through mid-July, 1952). All area figures are measurements made during this field period. All yield rates refer to 1951-1952 production and mid-1952 area.

With an estimated total cultivated area of 1,001,100 square feet, the average yield for all crops amounts to 2.0 katis per square foot, or 58 short tons per acre, per year.[1] The mean production per farm, for the 168 farms with ground crops, is estimated at 12,080 katis, of which approximately 11,540 katis are sold.

Choy Sam (Brassica chinensis, var. communis, spinach mustard), with approximately 72 per cent of total production and 52 per cent of total cultivated area, is by far the most important crop in the region. It is grown on approximately 155 farms, dominating both production and area on about 120 of these. Mean area in Choy Sam for the 155 farms is estimated at 3,340 square feet, and mean production is 9,380 katis, of

[1]For purposes of comparison with yield-rate figures for other areas, the rates given should be multiplied by .741 to take into account the area of bordering paths--rates given here refer only to the actual area of vegetable beds. However, comparisons made within the Island of Singapore among bed-grown leaf-stem vegetables should be based only on bed area, since path width varies throughout the island.

which about 9,020 are sold. With a total estimated production of 1,454,360 katis, or 970 tons, and a total estimated area of 517,100 square feet, Choy Sam has a yield rate of 2.8 katis per square foot, or 82 tons per cultivated acre, per year, the highest of any crop in the region.

Pak Choy (Brassica chinensis, v. communis, or B. parachinensis, Chinese white cabbage) ranks second in total production and fourth in area for the Lower Kallang Plain. It accounts for an estimated 6 per cent (by weight) of total production and total area. For the 82 farms on which this crop is grown, its mean area is 770 square feet, mean production 1,530 katis, and mean sale 1,460 katis. The estimated total production of Pak Choy is 125,420 katis (84 tons), total area is 63,130 square feet, and yield rate is 2.0 katis per square foot, or 58 tons per acre, per year. Sales are estimated to be 119,640 katis and consumption approximately 5,770 katis.

Sai Yung Choy (Nasturtium aquaticum, water cress) ranks third in production, accounting for about 5 per cent (by weight) of the total, and second in area with 13 per cent of the total. Production is estimated to total 105,410 katis, of which approximately 101,520 katis are sold. Total area in this crop amounts to about 125,930 square feet. Since Sai Yung Choy is grown in two contrasting ways--in puddled plots, in a manner slightly resembling padi, and in the usual raised beds--separate calculations for each have been necessary. For the plot method, yield rates are low--0.6 katis per square foot, or 18 tons per acre--and, though total area in Sai Yung Choy plots amounts to approximately 80,700 square feet, estimated total production is only about 49,900 katis, of which about 48,230 katis are sold. When grown on raised beds, in a manner ecologically similar to most leaf-stem vegetables, yield rates are estimated (somewhat inaccurately) to be 1.2 katis per square foot, or 36 tons per acre, with a production of about 55,520 katis and sale of 53,280 katis from an estimated 45,220 square feet. A total of 59 farms grows this crop: 33 in beds only, 12 in plots only, and 14 in both.

Kai Lan (Brassica alboglabra, Chinese kale) accounts for 5 per cent of total vegetable production (by weight) and 12 per cent of total area in crops, and thus ranks fourth in the former and third in the latter. It is grown on some 116 farms and is, therefore, the second most widely raised crop. Production amounts to an estimated 97,490 katis, or 65 tons, of which approximately 92,490 katis are sold. Total area in this crop is estimated to be 120,010 square feet, and yield to be 0.8 katis per square foot, or 24 tons per acre. For farms growing Kai Lan, the mean production is estimated to be 840 katis, mean sales 800 katis, and mean area 1,030 square feet.

Yin Choy (Amaranthus gangeticus, Chinese spinach or amaranth), accounting for 4 per cent (by weight) of total production and 3 per cent of total area, has a production estimated at 27,990 square feet. Its calculated yield rate of 2.6 katis per square foot (77 tons per acre) is close to that for Choy Sam. For the 57 farms growing Yin Choy, the mean production per farm is approximately 1,300 katis, sales 1,240 katis, and area 490 square feet.

Kang Kong (Impomoea reptans, water spinach) has an estimated total production of 60,290 katis (40 tons), total sales of about 56,590 katis, and total area of about 36,000 square feet. Neither these figures nor the calculated yield rate of 1.7 katis per square foot (48 tons per acre) is very accurate. Inaccuracies result from the following: (1) Kang Kong was often found growing under partially tended conditions, providing a low yield; (2) some farms harvest the crop in irregular stages over a long period of time rather than, as with most leaf-stem vegetables, at one time for each bed; and (3) both raised bed and wet-plot methods are used, with insufficient information being provided on each since the crop rarely attains importance. The crop is grown on some 40 farms--and is grown in unweeded, fallow areas on several more--with mean production on these farms amounting to about 1,520 katis, mean sales 1,410 katis, and mean area 900 square feet. Kang Kong accounts for roughly 3 per cent of total production (by weight) and 4 per cent of total cultivated area.

Chung (Allium Cepa, spring onion) is grown in this region for its green parts rather than its bulb, and is harvested before a bulb forms. Total production amounts to an estimated 39,900 katis (27 tons), with approximately 37,860 katis sold. Chung occupies a total area of 23,930 square feet, accounts for 2 per cent (by weight) of total production and 2 per cent of total area in crops, and has an average yield rate of about 1.7 katis per square foot (48 tons per acre). For the 45 farms on which it is grown, mean production is approximately 890 katis, mean sales 840 katis, and mean area 530 square feet.

Kan Choy (*Apium graveolens*, celery or Chinese celery), accounting for (very approximately) 2 per cent of total production and approximately 3 per cent of total area, has an estimated production of 36,030 katis (24 tons) of which 34,640 katis are sold, and an area of about 32,640 square feet, giving a yield rate of 1.1 katis per square foot (32 tons per acre). Production, sales and yield-rate figures for this crop are not very accurate, since irregular small pluckings rather than bed-by-bed harvest prevail on some farms. For the 56 farms growing Kan Choy, the mean production is 640 katis, mean sales 620 katis, and mean area 580 square feet.

Minor crops. Two additional leaf-stem vegetables are significant, though of minor importance. Kai Choy (*Brassica juncea*, v. *rugosa*, leaf mustard) is grown on 34 farms, has a total production of approximately 17,080 katis (11 tons), 0.8 per cent of the regional total, sales of 16,200 katis, and an area of 17,860 square feet, 2 per cent of the total. The yield rate is estimated, very approximately, at 1.0 katis per square foot (28 tons per acre). Sang Choy (*Lactuca sativa*, lettuce) accounts for only 0.2 per cent of total production and 0.7 per cent of total area, with an estimated production of 3,790 katis (2.5 tons), sales of 3,590 katis, and area of

7,100 square feet. It is grown on 21 farms and has a yield rate of, very approximately, 0.5 katis per square foot (15 tons per acre). Sugarcane (Saccharum officinarum) is grown on at least 25 farms and probably many more, but almost invariably as a home-consumed "sweet," primarily for children; rarely is it sold. Two crops used primarily for stock feed, sweet potato (Ipomoea batatas) and tapioca (Manihot utilissima), occupy about 13,130 and 2,610 square feet respectively; production and yield rates in this area could not be determined. The former is grown in 12 farms, the latter on 7. The remaining crops total 13,680 square feet in area. Names and number of farms on which each is grown are as follows: long bean (Vigna sinensis) 6; chilli (Capsicum annuum) 5; Yin Sai (Coriandrum sativum, Coriander) 5; Moh Kwa (Lagenaria leucantha, hairy guard) 2; and, with one report for each, Kow Choy (Allium odorum, Chinese chives); Kow Kei Choy (Lychium chinense, matrimony vine); cucumber (Cucumis sativus); greater yam (Dioscorea alata, sec. enantiophyllum); Brinjal (Solanum melongena, eggplant), and two unidentified gourds.

Since the present monograph deals with a relatively brief time-span, a discussion of crop origins is of use only insofar as it throws light on some of the historical-process questions discussed in chapters X and XI. Unfortunately, while some evidence as to historical processes is provided, it is not very strong. Slightly more useful information is obtained when we compare present-day distributions of the crops grown in the Lower Kallang Plain.

Every leaf-stem vegetable crop grown in the plain is recorded for Hong Kong by Herklots (1947). This fact is significant in itself: Hong Kong vegetable gardening can be equated fairly well with South Chinese, particularly Cantonese, gardening, and the presence of these crops in that area suggests strongly a South Chinese immediate origin for the vegetables introduced into Singapore. The problem is somewhat complicated, however, by the fact that Ochse (1931) lists an only slightly less complete array of these vegetables for the East Indies. The introduction of the same crops into the Indies probably occurred via the Chinese, at least in some cases, but we have no way of being certain about it.

Vavilov (1949-1950) considers the leaf Brassicas to be of Chinese origin. Herklots states that B. chinensis (choy sam and pak choy) is Chinese; for B. juncea (kai choy), however, he lists only "Asia" as its origin. Ochse (who does not list origins) states that B. juncea is common in the East Indies; one variety, however, is usually grown from seeds imported from China. The origin of B. alboglabra (kai lan) is not mentioned by Herklots, and the crop is not listed for the East Indies by Ochse. In general, it would appear that Vavilov's contention is supported by these sources. Brassicas, it should be noted, account for 72 per cent of total cultivated acreage in the plain.

No other leaf-stem vegetables are listed as being of definitely Chinese origin by Herklots. Allium odorum (kow choy) is called East Asian, as is Lychium chinense (kow kei choy). Significantly, Ochse shows that the East Indian names for the former imitate the Chinese name. Vavilov lists China as one of the origins of Lactuca sativa (lettuce); Herklots merely refers to an Asian origin; and Ochse states that lettuce is grown in the East Indies mainly for Europeans, suggesting, along with the ecology of the crop, a non-Malaysian origin. Although Impomoea reptans is widespread both in the East Indies and South China (Skvortzow 1920 discusses the crop for Foochow), the name used in Singapore, "Kang Kong," is Malaysian, raising the possibility that it was borrowed in Malaysia rather than carried from China, where it bears a Chinese name. Manihot utilissima, not mentioned for Hong Kong, and distinctly "tropical," seems likely to have been borrowed in Malaysia. For the remaining crops, Herklots lists the following origins, none of which provide any evidence as to whether they came to Singapore from China or elsewhere: Nasturtium aquaticum (water cress), Europe; Amaranthus gangeticus (yin choy), tropics; Allium cepa (choong, spring onion), South-west Asia. The origin of Coriandrum sativum (yin sai, coriander) is not mentioned by Herklots; Ochse refers to it in passing as a "South European" crop, and it is, of course, important in India, where the seeds rather than the leaves are used as a spice. Finally, it will be noted that crops other than leaf-stem vegetables are quite unimportant in the plain; their origins (varying from tropical America to Asia) do not assist us in the present inquiry.

The absence of significant evidence favoring a Malaysian origin for nearly all of the leaf-stem vegetables, and the somewhat variable evidence favoring a Chinese origin for some, appear, in general, to fortify the contention of this paper, that the Lower Kallang Plain farming system migrated more-or-less intact from South China to Singapore.

Livestock.--Livestock are of significance on few farms in the Lower Kallang Plain, and stock form a major source of income on fewer still. Only two farms report poultry income over $1000 per year; approximately 30 additional farms report income from pigs equal to or exceeding this amount. Poultry rearing tends to be a minor enterprise, found on about half the farms, while pig rearing, where undertaken at all -- on about one-quarter of the total number -- tends to be a major enterprise. The total number of farms reporting livestock of any sort is estimated to be 92, or 54 per cent of all farms in the area. Of these, 27 report both pigs and poultry (with the former providing by far the largest proportion of livestock income), 13 report pigs only, and the remaining 52 report only poultry. Ducks are present on approximately 28 of the 79 farms reporting poultry, but nowhere attain any importance. The farming system characteristic of the area is such that a major shift of capital, labor, and land resources would be required for the area to attain any significance as a livestock-producing region, and at present most farmers find it profitable to concentrate heavily on leaf-stem vegetables.

For the 40 farms reporting pigs, the total number enumerated is approximately 614, or an average of 15 per farm.

Of these, 68 are sows, and the remaining 546 are saleable, fattening pigs. In an area where pig rearing is both nominally illegal and small in scale, it is understandable that reliable reports of sales are inadequate. Based on the normal production cycle, and checked against report from this and other areas investigated, however, a five-to-six average ratio of saleable-on-farms to annual sales was determined to be moderately accurate. Applying this ratio to the remaining 29 farms, the total number of pigs sold during the year is estimated to be 655 for the 40 farms with pigs, or an average of 16 per farm.

The total of all poultry in the area is estimated to be 2,220 birds, or an average of 28 per farm with poultry. Chickens total approximately 1,770 birds, of which 550 are laying hens. Seventy-nine farms report chickens, with an average of 22 birds per farm. Total production of saleable chickens is estimated to be about 2,440 birds, of which very approximately 1,480 are consumed on farms and the remaining 960 sold. Egg production totals about 50,400 eggs for the year; approximately 31,080 are sold and 19,320 consumed. Ducks are reported from 28 farms, all of which also possess flocks of chickens. The estimated total number of ducks is 460, or an average of 16 per farm. Significantly, only 9 layers are included in the total. Total production of saleable ducks is estimated to be 1,070 for the year; approximately 530 are consumed and the remaining 540 sold. Production of duck eggs is in the neighborhood of 1,890, all of which appear to be consumed on farms. Because of the small numbers of poultry on farms, production reports are incomplete, and have been supplemented by calculations based on normal production rates and cycles, using data kindly supplied by the Agriculture and Veterinary departments. Tested against direct reports in this and other areas, these have proven to be fair estimates.

Tree Crops.--Fruit trees are reported from 59 of the 170 farms in the area; however, neither the number nor annual value is large for any farm. Only five farms report more than 10 trees each (excluding odd clumps of banana), and the average number of trees for the 59 farms (excluding banana and bamboo) is 4. The total count for the area is 242 trees of all sorts except banana and bamboo. One hundred and three small clumps of stems of the former, and 6 of the latter, are reported, but the total count of stems cannot be ascertained. Trees would seriously diminish sunlight for vegetables on these small farms, and this, in combination with the much higher value per acre for vegetables, may be the critical factor discouraging tree crop production in the area.

Few farms produce fruit for sale and thus most do not weigh or count the crop; as a consequence, production data are inadequate. However, by applying average yield rates under local conditions,[2] a rough estimate of production can be given. Following are the types of fruit trees found and, for each type, the total number of trees and estimated total annual

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[2]Yield rates have been obtained through the courtesy of the Department of Agriculture of Singapore and the Federation of Malaya.

production: coconut (Cocos nucifera) 75 trees, 3,000 nuts; guava (Psidium guajava) 59 trees, 2,950 katis; rambutan (Nephelium lappaceum) 23 trees, 69,000 fruits; jack fruit (Artocarpus integrifolia) 24 trees, 520 katis; sour sop (Anona muricata) 16 trees, 480 katis; belimbing (Averrhoa bilimbi) 8 trees, unascertainable production; jambu (Eugenia aquea) 10 trees, 150 katis; papaya (Carica papaya) 7 trees, 140 fruits; and, with five or less trees each and insignificant production: pomelo (Citrus maxima); durian (Durio Zibethinus); lime (Citrus acida); star fruit (Averrhoa carambola); and mango (Mangifera indica).

CHAPTER XV

PRODUCTIVE MATERIALS: ITEMS AND QUANTITIES

Tools and Equipment.--In this chapter, as in the preceding one, we shall be concerned largely with enumerating certain tangible, material elements in the farming system, in this case the items of material culture which are productively employed in the system. As with the discussion of labor and crops, we shall defer the question of functional participation, "use," of the materials, for later chapters, those dealing with crop ecology and the functional field as a whole. Certain of the material elements being dealt with in the present chapter warrant quantitative enumeration, among these being fertilizers, seed, and other materials whose input levels have an important effect on the intensity of the system. Others, such as tools, equipment, and productive structures, require only qualitative treatment.

Among the tools employed by Kallang farmers -- indeed, by all crop-farmers of Singapore -- one can be considered truly basic: the hoe (chungkol). It is a commonplace that so-called intensive Oriental agriculture can almost be identified with this implement; this is certainly the case in the Kallang Plain, and in Singapore as a whole. No other implement, hand manipulated or mechanical, could permit the high degree of production intensity per unit of land which prevails here, or, seen from another standpoint, could allow sufficient yield increments per unit of labor to justify the expenditure of an hour of productive time per square foot per year.

No systematic effort was made to measure hoes throughout the plain, so our description of what we shall call a typical hoe is compounded of measurements on one farm (that of Ng Hong) and general observations elsewhere. The kind normally used is rather long-handled, generally five to six feet long. The hoe blade is roughly ten inches long, rather squared at the tip, and about half as wide as it is long, broadening toward the blade. Shorter hoe handles were observed, although such hoes are supplementary implements. The handle is manufactured locally; the blade is probably imported.

A second pivotal item of equipment is the implement used for most hand-watering tasks. This consists of two water buckets fitted with spouts and suspended from a resilient bamboo shoulder pole. The spouts are tipped with a kind of baffle which directs the water outward and slightly upward in a thin sheet, providing a light wash spread out over a rather broad area. The buckets themselves may be wooden or metal. The latter, in some cases, are made out of kerosene tins; in others, out of sheet metal. Three buckets were found, on measurement, to be slightly over twelve inches high and twelve inches in diameter, and to hold roughly 1500 cubic inches of water when full. The entire apparatus seems to be manufactured locally.

Watering of seedlings is done with a small tubular metal pump, rather suggestive of a bicycle pump, which applies a fine spray to the beds. This implement is used in conjunction with a wooden or metal pail: While enough water can be carried in the dual-bucket apparatus to allow direct refilling from the ponds, the smaller watering pump must be frequently refilled from the bucket. This lighter implement is usually manipulated by women.

Both varieties of watering apparatus are, as we shall see in Chapter XVII, basic to the farming system in its present form. One qualification should be added, however. Were ecological conditions such that subsurface irrigation could be practiced, hand-watering could be eliminated from the system without altering it drastically, although the different soil environment implied would involve different fertilizing methods.

Several other varieties of field implements were observed to be in use in the plain. With the exception of shovels, which are used for deepening and maintaining ponds and drains, and rakes, none seemed of very great importance (i.e., used frequently, and non-substitutable). We might mention, however, the implement employed in spreading dry fertilizer. This is a wicker scoop, slightly concave and very roughly one foot in diameter.

A number of different wooden, metal, earthenware, and wickerwork (rattan) containers are used for various purposes. Metal pails are used as described above in watering with the small hand pump, and also for various other purposes, and smaller ones were noticed on farms raising pigs, where they are employed for carrying dilute pig manure. Roughly cylindrical metal or wooden ladles, affixed to a short pole which passes through the upper portion, were also observed to be used for carrying either dilute pig manure or decomposed, wet prawn dust to the beds. Large earthenware pots are scattered at various points on the farms, their use being to retain a mixture of prawn dust and water during the period needed for the former to decompose. Rattan baskets are used to carry vegetables to market and for various other purposes.

All, or nearly all, of the foregoing implements are in use in China, although wood replaces metal in most instances. Hommel's _China At Work_ (1937) and King's _Farmers of Forty Centuries_ (1911) provide illustrations of most. The only implement which may not be in use in China is the small hand-watering pump. Thompson (1957) provides a photograph of a dual-bucket, shoulder-borne apparatus used in market-gardening near Osaka, Japan, for carrying night-soil solution to the vegetable fields.

Finally, we should include here a brief mention of the equipment used for transporting vegetables and supplies to and from the farms. Some farms make use of trucks (which several farmers hire as a group) to convey their produce to market. On other farms, members of the family (usually males) carry the vegetables on a bicycle or on foot to a nearby collecting point where wholesalers buy the produce. (This latter marketing method is much less significant in the plain than elsewhere in the island, largely because the plain is closer to urban markets, and thus more directly accessible by farms, than any other producing area.) Some farmers may even bicycle into town with their vegetables. And finally, farmers carrying loads on foot to the motorable tracks, or from local supply shops, often make use of an apparatus consisting of two shallow rattan baskets suspended from either end of a bamboo shoulder pole.

Productive Structures.--It is conventional in farm management research to consider the farm dwelling a non-productive structure, and to treat only such structures as barns, pig sties, and like buildings as subject to costs-and-returns analysis in viewing the farm business as an economic system. Such a distinction appears to be unwarranted for this study, and, indeed, for any functional geographic study of agriculture, where all factors relevant to farmers' decisions and behavior, and their material consequences, are involved in the functional field being investigated. Thus the Kallang dwellings, which in some cases contain the farm stores but always provide the locus for many activities either directly involved in farming or related to it -- as in the competition for the women's time posed by household duties -- deserve at least brief description.[1]

The typical farm dwelling of the plain, rather similar to

[1]Any attempt at determining the origins and cultural affinities of the dwellings would carry us beyond the scope of this paper.

farm dwellings throughout Singapore, and probably also to Chinese rural dwellings elsewhere in Malaya, is rectangular, about 1,015 square feet in area on the average, and has its front door approximately in the center of one of the long sides. The roof is made of attap (palm fronds) thatched with rattan over poles, often has a zinc peak, and slopes toward the front and rear. Walls are of vertical wooden boards on a pole frame, interrupted by unglassed, sometimes wood-barred, windows. Many, perhaps most, are underlain by a concrete base (not a true foundation) and have an adjoining outdoor kitchen covered by an extension of the attap roof. Some devote a portion of the structure to farm stores; others have an adjoining shed in which stores are kept. In the former group, some of the larger houses keep the stores in a kind of attic. Rooms vary in number from one to three and perhaps more. Fig. 2 is a sketch of one such Kallang farm house.

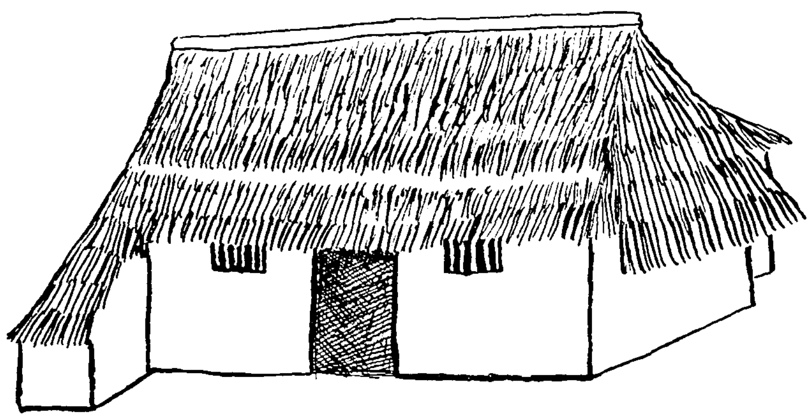

Fig. 2. Farm house in the Lower Kallang Plain.

The only strictly productive structures observed on farms were associated with livestock enterprises. Chicken coops are one such structure. In almost all cases they are small: Only two farms in the area report income from poultry (including ducks) to be over M$1,000. Forty of the 170 farms report pig-rearing as an enterprise, though a minor one; most of these have one or more pig sties of a rather well-defined type. The sties are attap-roofed, the roofs being supported by poles. They are floored with concrete, which often slopes toward a small concrete-lined pool along one side of the sty: Manure is washed across the floor and into the pool where it is left to decompose in water. (This sty-and-pool complex is much better developed on the mixed farms of upland portions of the island.) The sties usually have no walls: The peaked roofs descend well down toward the ground, providing good shade and protection for the interior. Individual stalls are separated from one another by wooden poles or bars. Generally the sties are rather narrow and elongate. (It should be noted that this is an island-wide norm for sty construction; Kallang farms usually possess smaller and often makeshift ones.)

We might include in this discussion of productive structures those shops and other buildings which figure in the farming system though they are not on the farms themselves. Two sorts of shops are important. One is the coffee shop, a variety of rural cafe which seems to be visited by most farmers every morning before they begin their field activities, and which may function as the chief locus of social contact and technical communication among farmers. The other, perhaps the most striking imprint of Chinese culture on the Southeast Asian landscape, is a kind of general store, retailing fertilizers, seeds, food, and general articles of merchandise. In some cases the two, coffee shops and retail stores, are merged. Also in certain cases the phenomenon of the "shophouse," in which the shopkeeper has his home either above or in the rear of the shop itself, is found, although adjoining dwellings are perhaps more common in the plain.

Fugitive Material Input Factors.--The rather cumbersome term "fugitive material input factors" designates a wide range of materials which are employed in the productive process but must be replenished after at most one crop cycle of one to two months. They are thus to be contrasted with the foregoing materials -- tools, equipment, and structures -- which, being what the agricultural economist would term capital equipment, persevere rather longer. The distinction is an important one: In the case of the fugitive items, the general level of farming operations, what we term the intensity of productive processes, varies closely and directly with quantity input of these items. Thus, to understand the intensity of the system, whether measured in terms of yields, income, or labor, we must know the quantities of such materials employed. This is not the case with capital equipment, where one-of-a-kind records for each farm suffice to tell us that the farm is not abnormal in the capital equipment it employs, where quantity or value of such items is at best only an indirect measure of the level of the farm business, and where the annual cost of all capital items taken together does not amount to more than a fraction of that for fugitive items.

The only serious problem which arises in connection with our definition of a class of materials as "fugitive input factors" is to distinguish between "material culture" elements and "natural elements:" Clearly, soil and water function as fugitive input materials in the same eco-system with fertilizers and seed, and all are considerably manipulated by farming behavior. However, if we avoid making a distinction between material culture and "natural resources," we can somewhat awkwardly sidestep this problem. On the other hand, the fact that we shall relegate the discussion of soil and water to a later section (Chapter XVII) implicitly recognizes that some sort of distinction has to be made.

Organic fertilizers, lime, "burnt earth" (see Chapters XVI and XVII), seed, pesticides, and stock feed are the important fugitive elements apart from water (and perhaps aspects of the soil and atmosphere).

In quantity, cost, and ecological significance, fertilizers are of predominant importance. The key permissive elements in crop ecology in this area are maintenance of soil physical condition and soil fertility. The former relates largely to labor, and thus to non-cash input factors; the latter depends almost exclusively on the level of fertilizer application.

The total quantity of purchased fertilizers of all types (except lime) used during the year is estimated to be about 1,671,860 katis, or 1,110 short tons. One fertilizer type, prawn dust (a dried waste of prawn fisheries), is predominant on nearly all farms--including, significantly, most farms with pigs and therefore pig manure. Prawn dust, amounting in quantity to about 1,650,640 katis, accounts for 99 per cent of the total. Minor fertilizers include sharks' fin (11,860 katis), fish waste (8,600 katis), and various low-grade oil cakes (760 katis). While these latter are of essentially no significance in the total quantity and cost of fertilizers, traces of them are used on about thirty-five farms, usually for special purposes such as rapid action during sudden spells of high prices. In addition to the quantity of purchased fertilizers reported, all farms raising pigs use farm-produced pig manure, as might be expected. None of the farms supplied usable figures on the amount of pig manure produced. A significantly lower prawn dust application rate prevails on such farms; however, in calculating the quantity of pig manure used, indirect inference from the difference between the otherwise-expected and the actual prawn dust application rates on such farms, adjusting for the relative efficiency of the two, is less satisfactory than assuming normal manure production rates for pigs. At the normal rate[2] of four katis per pig per day, the total annual production is estimated to be 896,440 katis. This cannot be compared, quantity for quantity,

[2]Figure obtained through the courtesy of the Department of Agriculture, Singapore.

with prawn dust, since, in part, the former has nine times the moisture fraction of the latter, and since the former is applied indirectly and therefore suffers a weight loss through disintegration. Finally, night soil may be used on from three to eight farms, and human urine is used indirectly (via ponds) on most. A fact worth noting is the absence of any reports of the use of artificials, or of any inorganic other than lime.

Using a figure of 99,600 katis, or one-ninth the normal production, for pig manure, the total annual quantity of fertilizers of all types except lime is estimated to be 1,771,470 katis, or 1,180 tons, giving a mean rate of application per square foot of about 1.8 katis. Of significance, also, is the mean application rate for prawn dust, about 1.6 katis per square foot. These values convert to applications per acre of 52 short tons for all, and 48 for prawn dust. Accuracy of all quantity figures for purchased fertilizers is somewhat below that for yield and production, and is, in the main, limited by two important sources of error: (1) Since farmers buy fertilizers frequently, in varying amounts (bags of various weights) and at irregular intervals, and since most appear to trust the dealer to keep records of quantity and value rather than keep records themselves--many are incapable of doing so--reports of quantities purchased are, on the whole, inaccurate. It has been necessary in most cases to work from the standpoint of normal applications--number and quantity per bed per cycle compared with cycle length and bed area for each crop--and this increases the expected errors.

Although such errors compensate, a bias in favour of recent application rates is probable--this, however, counterbalances the same bias in yield rates. (2) Direct reports of application rates cover only 55.7 per cent of total cultivated area, while indirect calculation--predicting from yield rate on the basis of a linear estimating equation (16.1 per cent) and predicting from the mean application rate (4.1 per cent) --cover only an additional 20.2 per cent. The calculated quantity of minor fertilizers is considered to be somewhat too low, since it does not include many cases where unascertainable small amounts are used. In such cases the total quantity estimate included the minor fertilizer, subsumed under prawn dust rates, and, since both value and efficacy are reasonably similar to prawn dust, the total for any one farm will not be significantly altered. Application rates for choy sam have been used for areas in sai yung choy, kai choy, and yin sai, and are therefore somewhat too high for these crops. This adjustment has been made necessary by the absence of prices for these crops, the need, therefore, to treat areas in them as for choy sam, and the resulting need to balance the income adjustment by an expense adjustment. Selective application rates can be provided for most of the major crops, although a substantial margin of error must be assumed for all but choy sam. Mean rates of application of prawn dust per square foot per year to these crops are: 1.9 katis for choy sam, 1.2 for kai lan, 1.6 for pak choy, 1.6 for kan choy, and 1.9 for choong. (Rates for minor fertilizers, including pig manure, are roughly in proportion.) For the 168 farms with ground crops, the mean annual quantity of prawn dust applied is about 9,820 katis; of all fertilizers, 10,540 katis.

Lime, which functions somewhat differently than other fertilizers, is applied at the very approximate rate of 0.1 katis per square foot per year. The estimated total quantity of lime used on all 168 farms is 104,020 katis, or an average of 620 katis per farm, for the year.

No data on quantities of pesticides used can be provided, and estimates of seed and planting material quantities are unreliable for all but three crops (choy sam, pak choy, and choong). However, neither input factor is of considerable importance in the regional farm economy--though both are, of course, important in agronomy and crop ecology.

A seeding rate of .03 tahils per square foot per year (or 70.8 katis per acre) has been found to be accurate for choy sam, since both the reported mean seeding rate and reported mean annual seed purchase (for farms not growing their own seed) in relation to area are in close agreement. (Annual purchase divided by area in choy sam gives a mean seeding rate of .026 tahils per square foot. Seed per bed per cycle gives a mean rate of .023 tahils per square foot per year. The former was selected as the most accurate.) For this crop, then, the total weight of seed used during the year is about 840 katis. A somewhat uncertain average rate of .05 tahils per square foot per year has been obtained for pak choy, giving a total seed use of about 200 _katis_ for the year. (By the purchase method, the median and modal quantity per square foot per year give a rate of .05 _tahils_, while the mean rate is .068 _tahils_. By direct reports of seed per bed per cycle, the mean rate is .030.) For choong, the average weight of bulbs used per square foot per year is probably between .52 and .78 _katis_. (The former figure is obtained from purchase reports, the latter from seeding reports. Since neither is firm, the mean of the two--.65--will be used in calculating value.) While a reliable figure cannot be provided for yin choy, the rate cannot be much over .01 _tahils_ per square foot per year. No usable figures have been obtained for other secondary and minor crops, and the propagation methods used for kang kong and sai yung choy do not appear to involve seeding in most cases (cuttings from the prior crop are most frequently reported).

Tuba root (_Derris elliptica_, Derris) is the most important pesticide, accounting for 54 per cent of all product reports. The remaining 46 per cent consist of commercial pesticides of various sorts, especially DDT. Of the latter, DDT solution (notably a preparation bearing the name "Kadol") accounts for the largest proportion, with 33 per cent of all product reports. Powdered DDT preparations and miscellaneous preparations serving various functions account for the remaining 13 per cent. The most frequent response states the use of both tuba root and DDT solution. Tuba root has been an important pesticide in Singapore for some time; it is significant, therefore, that commercial preparations, mostly introduced after the recent war, have become widespread and important. Data on quantities of each type used have not been obtained.

An accurate figure for the total quantity, and the quantity of each type of stock feed used cannot be given, since frequent small purchases and small annual totals prevail on most farms. However, the value of stock feed in relation to stock sales has been computed, and from this a crude estimate of quantity can be given. On most farms with significant numbers of animals for sale it has proven possible to compute accurate ratios of production value to feed value, and from these ratios to predict feed value where no direct reports are given. A mean feed price has been calculated, based on the weighting of feed types by numbers of reports, accurate to within 10 per cent since prices of major feeds vary only from $20-30. The resulting figure is 267,700 katis.

The types of purchased feedstuffs, and the relative importance of each, stated as a percentage of all reports, are as follows: copra waste, 37 per cent (This figure includes a few reports of oil seed cakes); rice bran, 27 per cent; broken rice, 20 per cent; fish waste and unsaleable fish, 6 per cent; maize, 4 per cent; prawn dust and unpolished rice, each 3 per cent. One report of sago was obtained. Farm-produced stock feed includes water hyacinth (grown haphazardly in ponds on most farms), food scraps, and, in a few cases, sweet potato (grown primarily for the feed value of its green parts) and tapioca.

CHAPTER XVI

BEHAVIORAL ELEMENTS

Productive Tasks and Division of Labor.--In this chapter we shall be dealing with three topics centering around the productive behavior involved in Kallang leaf-stem vegetable farming: first, with the individual productive tasks themselves, the relatively discrete operations involved in production and supplementary activities, and with the segments of the farm labor force undertaking each; second, with the quantitative significance of each task, measured by its scale of labor use, or proportion of the productive time budget; and third, with the cycles of productive activity, the periodicity of tasks and labor input in relation to time of day and crop cycles. While the third topic will be dealt with last, one aspect of it, the sequences of tasks in the crop cycle, will be discussed in relation to both the first and second topic as well.

Productive tasks can be divided into several groups, each group being associated either with a particular phase in the typical crop cycle or a particular ancillary operation (e.g., marketing). Because of the association of tasks with phases in the cycle, we might at this point distinguish such phases. The operations involved in fitting a bed and all others involved in seeding, including tasks performed immediately after the seeds have been set, may be termed Phase I. Phase II would include those carried out during the period when the seedlings are growing in the nurseries, Phase III those involved in transplanting and the operations immediately following the setting out of half-grown plants. The subsequent period, during which the crop is in what we shall term the "maturing beds" to distinguish them from the nurseries, constitutes Phase IV. And finally, the sequences of operations, lasting through one afternoon and evening and the following morning, involved in harvesting the vegetables, preparing them for market, and marketing them, will be referred to as Phase V.

A number of tasks cannot be identified with particular phases of the typical crop cycle, since they occur either at frequent intervals throughout the cycle (daily in the case of watering) or at irregular intervals. A number of other tasks bear little relation to the crop cycle, since they involve secondary enterprises such as pig-rearing. And finally, while the crop cycle which we have been discussing is one held in common by nearly all crops, at least in terms of its qualitative attributes, certain special crops are quite different in both their mode and cycle of production, and separate tasks are involved.[1] Understandably, our attention will focus on

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[1]Atypical crops of this sort include essentially all non-leaf-stem vegetables, small amounts of which are grown on many farms, water cress when grown in saturated plots rather than beds, and kang-kong when grown in ponds or as an untended crop on waste areas. (Some water cress and, to a lesser extent, kang-kong is grown in beds according to the typical process.)

the "normal," i.e., time-consuming, tasks, and all of these relate to crops, rather than livestock, and to those crops possessing the typical crop cycle.

Division of labor based on age and sex is rarely clear-cut, although children are very largely excluded from certain arduous or skilled tasks. While, in general, certain tasks can be identified with men and others women, many instances were recorded where, for one reason or another, or sometimes for no discernable reason, sex division of labor was obscured and even, occasionally, reversed. To illustrate this, observations carried out during the "activity analysis" (see below) showed that each field task was performed by both sexes on some farms, and children as well participated in all tasks although to a very minor extent in the case of strenuous tasks (watering, transporting crops) and those involving a high degree of skill (fertilizing, planting).

Since sex division of labor is not perfectly sharp for any single task, it appears useful to employ a rule-of-thumb index to state the degree to which a given task is "male" or "female." Such an index can be derived by using the proportion of adult male participants working full-time to all adult female participants, a ratio of about 9:17, or 36 per cent for the former and 64 per cent for the latter. Adult males working part-time are excluded here because our observations were carried out on weekdays and it can be assumed that men working elsewhere would not carry out farm tasks during this time, except possibly during the evening hours which do not figure in the quantitative analysis.

From the above it will be seen that a task breaking down into 36 per cent "male" and 64 per cent "female" would be "normal," i.e., neither conspicuously "male" nor conspicuously "female." This we will call 100. Deviations will be measured in relation to the "male" percentage: A task undertaken by men in 72 per cent of the observations will be given an index of 200; 50 if in 18 per cent; 250 if in 90 per cent, etc. Obviously it would be impossible to construct such an index for child labor as well, so the contribution of children in the labor force will have to be dealt with separately.

The data from which the following discussion of productive behavior is drawn derive from three distinct field-work procedures, and a note on these seems desirable. Quantitative reckoning of the number of men, women, and children employed in each field task at each hour of the day (from 6:30 AM to 8:30 PM) was obtained from what may be termed an "activity analysis" of a segment (about one-quarter) of Lower Kallang farms. Investigators walked along a route parallelling the river and observed all productive behavior on farms between the route and the river. Each task was recorded as to the number of men, women, and children undertaking it and totals were obtained for the area observed. These observational traverses were repeated over a period of days until three such traverse reports had been assembled for each hour of the day.[2] Since these data are obviously less than representative of a year, they must be interpreted with caution. Longer records were ruled out for lack of time.

The second and third procedures were involved in two of the major field techniques discussed in Part I. Several of the questions asked "selected farmers" dealt with farming operations, the individual tasks and the time taken. And in the basic interview farmers were asked similar, though less detailed, questions about a single bed.

Initial preparation of a bed for planting (Phase I) or transplanting (Phase III) involves several operations and allows several alternatives. If the bed has been lying fallow only overnight, the typical case, fitting the bed involves the following tasks. First, the chungkol (hoe) is used to break down the soil of the bed into relatively small clods. In some cases this is preceded by cleaning the adjoining path of grass and weeds, and heaping these on the bed. Mud may be drawn from the farm ponds and spread over the bed at this time also: This mud is recognized as being silt washed originally from the beds themselves. After the first breaking up of the soil, lime is usually added, and sometimes also prawn dust. Next, the beds are shaped, the edges cut away, and soil which had washed down to the paths during the preceding crop cycle

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[2]The 6-7 PM hour has only two reports; the 7-8 and 8-9 PM hours have only one report each. Values for 6-7 PM were multiplied by 1.5 to make the data comparable. Those for the 7-9 PM period were left out of the quantitative analysis because one record provided inadequate data; little productive behavior took place during this period in any case.

is thrown up again.[3] Finally, the clods are worked over again, with a rake in some cases, to produce tilth of requisite fineness. For nurseries the process is done with painstaking care, the end result being a bed of very finely broken-up soil. (See Plate III.) Less care is taken for beds being prepared for maturing the seedlings.

Normally, these tasks are undertaken by men, the index being 161 for the basic tasks. With the possible exception of hand-watering, this is the most arduous set of operations on Kallang farms. Even so, women carried them out in about 40 per cent of the cases and children under sixteen in another 5 per cent on farms observed during the activity study. This can only be accounted for by a lack of sufficient male labor on many farms.

When longer periods of fallow have preceded the seeding or transplanting operations, different techniques of bed preparation are involved. In one case where an area had been fallow for several months, and had acquired a foot-high cover of <u>lalang</u>, the following initial operations were carried out. The <u>lalang</u> was first uprooted by hoeing, this operation taking place in the morning. By afternoon the grass had dried enough to be burned. Burning the <u>lalang</u>, the farmer explained, provided an exceptionally good initial increment of fertility in

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[3]One farmer provided the following comments on this operation (in the translation of the interviewer): "The beds are not built too high or too low because, if the bed is high, the roots of the vegetables will not get enough moisture on dry days since the top of the bed is dried up quickly. On the other hand, if the bed is too low, the roots of the vegetables will...rot off. The height of the beds depends on the locality of each farm."

Plate II

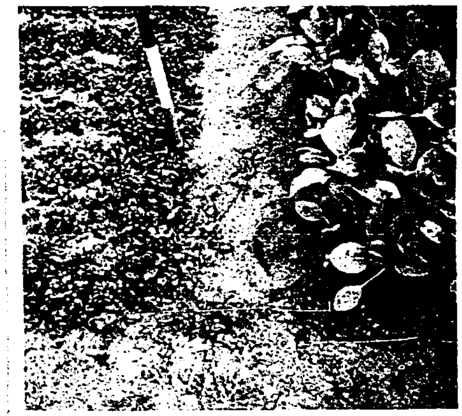

Plate III

Plate II. General view of a Lower Kallang Plain vegetable farm, showing the vegetable beds and farm house, the latter rather more elaborate than most. (Photo by Dr. Ivan Polunin, University of Malaya.)

Plate III. Close-up of the corners of two vegetable beds. That to the left has a crop of young seedlings emerging; note the fine tilth and transverse rows. That to the right has a nearly mature crop of choy sam. (Lower Kallang Plain.) (Photo by Dr. Ivan Polunin, University of Malaya.)

Plate IV

Plate V

Plate IV. Ng Hong watering a bed of newly transplanted choy sam. Note the thin film of water applied to the bed. (Lower Kallang Plain.) (Photo by Dr. Ivan Polunin, University of Malaya.)

Plate V. Harvesting a bed of choy sam or pak choy. (Lower Kallang Plain.) (Photo by Dr. Ivan Polunin, University of Malaya.)

the form of ash. The same afternoon the soil was thrown up into a bed for transplanting choy sam seedlings, water was applied, and the seedlings put in. Our observer did not record particulars of these operations, but it can be inferred that the grass plants were pulled out, loose earth being shaken off, and then were laid on the ground to dry before burning. A second, finer, re-working of the soil followed, with lime being added to serve as an insecticide (according to the farmer) and to further loosen the soil. (See below and Chapter XVII.) Again by inference, it appears that fitting the beds occurred before the final planting and watering.

Before the seeds are planted in a nursery, water is usually applied, if the day is dry, using the small hand pump so as not to disturb tilth. (Some farmers defer watering until later, fearing that the lime will be dissolved too rapidly.) Seeds are set in rows transverse to the longer dimension of the bed. At this point (although sometimes before planting) prawn dust is applied, although some farmers indicated that they could not afford to do so at the time of seeding, and waited until a few days later. Finally, long palm fronds are laid gently across the bed to provide shade and lower surface temperatures during the first few days of growth in the nursery.

Transplanting operations involve roughly the following sequence of tasks. First, late in the day a bed of seedlings is culled for individual plants considered to be large and sturdy enough for transplanting, and for those growing close enough to one another to compete seriously. These are brought over to the newly worked bed in small bunches, and then are planted individually, in rows (perhaps four to five inches apart) running transverse to the length of the bed. Apparently watering of the new bed normally takes place before transplanting to avoid laying-over of the delicate seedlings; on at least one of the nine selected farms providing detailed information on productive behavior, however, a second watering took place after transplanting -- perhaps with the hand pump rather than watering bucket -- on dry days.

The complex of tasks involved in planting and transplanting, excluding watering and applying fertilizer, divides about evenly as between male and female participants; 34 per cent of the adult labor is male, giving the complex an index of 94. Child labor is insignificant, perhaps because of the skill required in these tasks.

Between planting and transplanting or transplanting and harvesting of the leaf-stem vegetables, several tasks are carried out at frequent intervals. These include watering, fertilizing, and weeding, the first two of which are in themselves complexes of many operations.

Watering, as has been indicated, employs either the shoulder-borne, dual-bucket apparatus (Plate IV) or the lighter hand pump. As a general rule, women use the latter and both men and women the former -- women only when male labor is not available on a farm. (Unfortunately, the activity observations were undertaken before the important difference between these two varieties of watering operations had been discerned; as a result, no distinction was made between the two in field records, and we cannot either prove the sex-division mentioned here or determine the relative amounts of labor involved in each of the two.)

When watering with the shoulder-borne buckets, the farmer walks down a small wooden plank, or simply down the bank, into one of the ponds on or adjoining his farm. When he is about waist-deep he stoops forward and fills the buckets, then carries them out of the pond to the field. He walks between two vegetable beds, watering one or both beds (Plate IV).[4] On at least one farm, and probably several, the amount of water scooped up into a bucket depends on the size of the bed being watered, the aim being to exhaust one bucketful per bed: This raises the interesting question of whether the area of one bed is selected so as to conform to a norm in water needs of the plants on that bed, or at least to the water needs at a major stage of growth (seedlings on this particular farm require two, instead of one, load). It is certainly true that the lengths of beds in the plain tend to be similar, and the

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[4]One farmer commented as follows on watering, the remarks being as rendered in the interview report, and perhaps slightly colored by the interviewer: "There is an art to watering a bed. The spouts...should not be too high from the bed or too close to it. If the spouts...are too high, the sheets of water coming out from them will thin out and be broken by the breeze, with the result that there will be an uneven distribution of water along the bed of vegetables. If the spouts are too close to the bed, the force of the water will be too great. If the bed does not require much water, the farmer will water it at a quick but steady pace, so that less water is applied. If a bed is dry, he...waters it at a slower pace."

widths are almost identical -- although probably for other reasons, relating to other operations as well as watering. Watering of the sort described above is done for maturing plants, except those very recently transplanted (and therefore liable to laying-over), and for well-developed seedlings.

Watering with the light, tubular, hand-pump is undertaken for newly prepared beds, for seedlings during at least part of their early growth period, and sometime for transplanted crops during the first day or so in the maturing beds. Although no records were kept of sex-division as between the two watering tasks, the writer does not recall seeing men employ the hand-pump, while the heavier apparatus seems to have been used largely by men, an observation supported by the relatively small number of farms with no full-time male labor available. For watering as a whole, the index value for division of labor on the basis of sex shows a slight male emphasis, the value being 114, but the fact that the strenuous task of working with the dual buckets is largely a male activity suggests that watering should be considered much more of a male task-complex than the index value would indicate.

Three distinct tasks are involved in fertilizing. In descending order of importance on the basis of time input, these are: applying dry prawn dust; applying lime; and applying wet, partly liquefied prawn dust. Although other fertilizers are occasionally used, prawn dust and lime are the only ones of any significance in the plain. ("Burnt earth," which functions in part as a fertilizer, will be discussed separately below.) Since liming is generally carried out at the time of seeding, we shall limit our discussion largely to prawn-dust application.

Prawn dust in dry form is applied two to four times during the entire crop cycle. The first time is usually on the initial day of the crop cycle, when the bed is prepared and seeded. Sometimes a second application is made during the period seedlings remain in the nursery. Another is given the maturing bed at the time of, or shortly after, transplanting. And some farms regularly add a final one within the last two weeks of the growth period (one week or more after transplanting). Dry prawn dust is applied by means of the scoop described in Chapter XV, or by hand (in the case of application to beds with young seedlings, and perhaps at other times), the fertilizer being carried either in a basket or bag to the field.

Prawn dust in liquefied or partly liquefied form appears to be employed only in special cases. Two such were noted during the investigation. Ng Hong keeps a certain amount of prawn dust in this condition for use when the price of any crop suddenly rises: The liquefied prawn dust acts much more rapidly than dry prawn dust, and permits him to take advantage of what are usually short-term price rises. (He states that a noticeable spurt in crop growth occurs within twenty-four hours after application of the wet fertilizer -- a point we could not verify.) On another farm, No. 116, liquefied prawn dust was used regularly for the yin choy (Chinese spinach) crop.

The woman operator of this farm states that yin choy requires more fertilizer, and by adding some of the liquefied prawn dust to the water applied to the crop each afternoon, in a ratio of about one part liquefied prawn dust to twenty-five parts water (we do not, of course, know the weight of dry prawn dust involved), she increases her fertilizer input. Here again we could not verify the point regarding special needs of yin choy. It is worth noting, however, that the operator of this very small farm (3,300 square feet in cultivation) also practices what seems to be very heavy hand watering.

The degree of universality of applying prawn dust in liquid form was not determined in the study. However, many large earthenware pots were observed throughout the plain, and most of these were described as receptacles for decomposing prawn dust in water: The odor given off by this aromatic mixture is, in addition, difficult to misidentify. Further, although the operator of farm No. 116 diluted the mixture in a watering bucket, other farmers may apply it undiluted, with a ladle, much as the fruit-earth vegetable farmers apply liquefied pig manure.

As with watering tasks, no differentiation among the different fertilizing tasks described above was made during the activity observations. This was due in part to the necessity of keeping our check list of observed tasks as simple as possible. As a result our data on sex division of labor for fertilizing tasks must be presented as though the task complex were an undifferentiated whole. Presented in this fashion they reveal rather little: The index of sex division yields a value of 126, showing a rather marked tendency for the tasks to be carried out by males; however, nearly half of the observed male participation came after 5:00 PM, suggesting that male members of farm families employed elsewhere during the day, and returning late in the afternoon, might very well have altered the pattern by carrying out these tasks after their return -- our index, it will be recalled, relates full-time male labor to female labor, since these are the only roles which were accessible to the activity observation procedure. (Excluding labor performed after 5:00 PM, the index drops to 115.)

It is in the tasks performed at the end of the crop cycle -- harvesting, washing the harvested crops, and marketing them -- and in weeding, that female participation is more marked. In harvesting and weeding, as well, children add a significant contribution. For harvesting, the index is 73, and children make up fully 26 per cent of the number of participants observed. For weeding, the index is about 100; children add, roughly, 1 per cent (by time) to the labor contribution of adults. Washing of the vegetables and assembling them into market loads were observed to be family tasks, with women apparently predominating; no quantitative data were obtained, however. Marketing, by reports given us on marketing methods rather than in the activity observation -- since marketing takes place before dawn -- proved to be almost exclusively a task performed by women.

Weeding seems to be a task undertaken irregularly, rather than as a separate operation carried out at specified times. This is particularly true when men participate; women, however, sometimes go into the field for a period and do this task alone, while children involve themselves in few other productive tasks up to the time (about 3:00 PM) when harvesting becomes important. The activity of weeding seems to be given a low priority: Farmers responded to questions on this task by saying only that they do a bit of weeding when they notice the odd weed. Apparently volunteer plants have little chance of competing with the fast-growing vegetables, and the occasional one which does succeed is plucked sooner or later by the farmer while he is undertaking some other task, or by the women or children searching about for such individual weeds.

The sequence of tasks involved in harvesting can best be illustrated by reference to one crop, choy sam, the most important single crop in the plain. Most others are harvested in a similar fashion; deviations will be considered later. (See Plate V.)

Choy sam beds are harvested in the afternoon or early evening by the entire family. Most farms have at least one, and usually several, beds of this crop in a condition ready for harvest every day. In contrast to the transplanting operation, harvesting of a bed is done in a single operation, the entire bed being cleared on the same day. This results in a variety of sizes being obtained, and most farms appear to grade the plants in at least two size-groups. (Since choy sam is sold for its green portions, and is not allowed to reach full maturity, the only significant difference among the grades appears to be weight.)

One or more members of the family carry out the harvesting operation on a bed in the following manner. The individual or individuals crouch down beside the bed and, if right handed, pluck the plants with the right hand, transferring each plant to the left hand until a handful of perhaps twenty-five has been obtained. This is then laid carefully on a cleared portion of the bed, and subsequent handsful are laid on top of it. The clearing proceeds inward to the middle of the bed, then along the succeeding row to the right of the first, and so on, until all plants within reach have been plucked. At this point the harvester moves to the right, begins to pluck additional handsful, and lays the plants in a new pile. Thus he (or they) proceed counterclockwise around the bed until it is entirely cleared, and has a number of piles of choy sam at intervals around it.

During or after the plucking, withered and damaged leaves are picked off the plants; after plucking the bunches are shaken to remove soil from the roots (which have not been separated off), and the roots are picked clean of additional loose soil. Finally, the plants are taken over to one of the ponds, and an individual washes them carefully in the water to remove whatever soil remains; this last appears to be the most tiring part of the operation. Bunches of about fifteen <u>katis</u> (twenty lbs.) each, on the average, are assembled and (in at least some cases) tied. Finally, they are carried to a place in or next to the house where they are left until the following morning. In some cases the bunches are left in baskets, in others on wooden shelves. The plants are wet when laid out in this manner, and may be further moistened during the evening to reduce desiccation and therefore loss of weight and quality.

Other crops are, for the most part, dealt with in the same way. Kai lan, however, is cut at the base of the stem with a knife rather than being pulled out entire. In the case of kai lan, yin sai, non-leaf-stem vegetable crops in general, and perhaps other crops as well, beds are harvested in stages; during the harvest period each bed is searched for plants judged to be ready for harvesting, and these are plucked individually. This operation requires considerably more care in order to avoid damaging the roots of plants other than the ones being harvested.

As indicated above, the entire family participates in harvesting, excepting only the younger children and adults otherwise engaged. (Between the hours of 5:00 and 6:00 PM, the peak harvesting period, about half the adult women and one-third of the adult men working in the fields are engaged in these tasks.) With an index value of about 72, the tasks are seen to be undertaken more frequently by women than men; indeed, the probability that adult males working off the farm in some cases contribute their labor to this task in the evening hours suggests that sex division is even more pronounced than the index value shows.

Marketing of vegetables takes place in any of a number of different ways. Approximately two-thirds of the farms make use of trucks to carry the vegetables (with one of the farm women) to town, where most sell wholesale at informal street markets. These trucks are hired cooperatively by a group of farmers in some cases; in others, the trucker is paid a toll. On remaining farms the methods of selling the crop vary widely. Some few send a member of the family -- apparently in all cases a woman -- to one or another place in town to sell retail. Others, it appears, carry the crop to a collecting center near the plain where it is sold wholesale. Still others sell on the farm to "hawkers," itinerant peddlers who retail the crops themselves or perhaps sell them wholesale at a higher price in town. Among farms employing this latter method of selling, on some the crop is harvested by the farm family and sold the same evening to a hawker (with whom an arrangement has been made in advance of the harvesting), while on others the hawker does the harvesting himself. In general, it seems that retail selling pays best, but is only employed when small quantities of vegetables are involved, as a result of which it seems to be used only by smaller farms. Selling to hawkers pays least, and is practiced in some (perhaps all) cases only when a farm is either short of labor or has an insufficient amount for sale to compensate for the cost of transporting crops to market.

The operations involved in the modal marketing technique, transporting crops by lorry to the city, tend to follow a rather uniform pattern. Very early in the morning, usually between 3:00 and 4:00 AM, one of the farm women (perhaps in some instances more than one) carries the crop to the nearest motorable road, Braddell Road at the north end of the plain or either of the tracks skirting the plain on the east and west. (No instances of farms using the western track were noted, but many farms did not specify the route used.) Here the truck is met, and the woman proceeds into town with her vegetables. Several streets in the center of the city serve as informal wholesale transfer points, the women laying out their wares and wholesalers and retailers buying from them. (Apparently the process of bunching vegetables into approximately fifteen-*kati* lots is done in conformance with the needs of these markets, selling of lots this size being easiest.) Generally, prices received for the vegetables go downward as the morning progresses and needs of the buyers become satisfied. Since, as we shall point out in Chapter XVIII, farmers have no definite advance knowledge of market prices which a given day's harvest will realize, it would be desirable in theory for the women to return for a second load if prices on a specific day prove exceptionally high. But the hour-by-hour decline in prices, coupled with the need for a new harvest and the time taken in travel, preclude this. Finally, the women return to the farms about 6:00 AM, taking a rough average. Although no instances of failure to sell off the entire crop were noted, this may very well occur.

A number of relatively minor tasks should be described briefly before we consider the time budget and cycles of activity. Commercial pesticides are applied regularly, the most common one being a DDT preparation put up by Imperial Chemical Industries. Fertilizers other than prawn dust and lime are used on some farms, each requiring its own mode of application. Night soil is among these, even though it is technically illegal to use this material.

Certain special crops require operations other than those described above. One such unusual set of operations is involved in the growing of water cress in plots rather than beds. Here the soil is puddled to a depth of perhaps one to two feet, and the crop is grown in this saturated medium. Clearly, methods of production are markedly different from those employed for water cress when grown in beds, and for other leaf-stem vegetable crops. The necessity of having a more finely divided soil leads to the expenditure of as much as two man-days on preparation of a plot, the tasks including, usually, rough tillage, addition of lime (and perhaps prawn dust), building of bunds to retain water, flooding of the plot, puddling, and transplanting. (Whether dry seedbeds are used to grow the seedlings was not determined.) While the area under water-cress plots is not very great in the plain, it is of interest that this production system is the only one in the plain even remotely resembling that employed elsewhere for wet rice cultivation. Kang kong, or water spinach, although normally grown in beds, is sometimes grown in ponds, where it receives little attention. While the operations used also differ from those used for bed crops, and crop-ecological conditions involve an anaerobic substratum, we cannot speak of a definite production system, either similar to or different from water cress and wet rice, as being involved. And lastly, the fruit-earth vegetables grown in the plain differ in productive tasks from leaf-stem vegetables. Most striking differences, perhaps, are those resulting from the technique of lifting the green portion of sweet potatoes, legumes, and cucurbits onto trellises or poles. This is, in some cases at least, a deliberate device to save ground space, i.e., to obtain comparable yields for smaller areas.

The preparation and application of "burnt earth" is a task of some importance. The function of this material will be discussed in the following chapter; at this point only its mode of preparation will be discussed. Burnt earth is a mixture of soil and organic matter which has enough of the latter in it to smoulder for some time after being fired, until the organic matter has partly turned to ash. In some cases, at least, the mixture is kept smouldering while successive additional layers of soil and organic matter are added, those portions which are sufficiently cooked being removed from day to day as needed. While most farmers who were asked to describe the process spoke of lalang as being the important organic additive, and several claimed that a farm could sustain a burnt earth pile only if it had areas of wasteland in lalang, the writer observed farms on which only weeds and vegetable waste were used. The soil put into the mixture comes either from whatever has washed off the beds or from ponds; occasionally, mud from the drains or river is also used. Application of the mixture takes place at the time a bed is being prepared for planting or transplanting; the burnt earth is sprinkled over the bed after the first hoeing has taken place. Occasionally ashes alone are used. There appears to be a certain amount of substitutability among burnt earth, lime, and ash.

We may mention in passing the complex of tasks involved in tending livestock. Since few farms emphasize this enterprise, the actual operations associated with it need not concern us here. Pig-rearing involves a major effort in ..ling down vegetable feeds, notably water hyacinth, which is obtained from ponds in the area, where it is sometimes grown deliberately and sometimes appears as a volunteer plant considered undesirable and therefore sold to pig-rearers for very little. Purchased feed concentrates are added to the boiled food, as are sweet potato tops -- pig-rearers sometimes grow sweet potatoes for the tops along -- and tapioca. Tapioca is fed to chickens, as well. The highly integrated complex of tasks by which pigs produce manure for the vegetables, and these in turn serve as pig-feed, is of considerable interest, but unfortunately beyond the scope of this paper. Here we might simply note that pig manure is washed into a pit, where it is dissolved with water and weeds and ultimately used as a semi-liquid fertilizer on the crops, some of which return to the system as pig feed. Input materials are thus limited largely to purchased feed concentrates, while output consists of animal protein and usually some vegetables as well. Seen from an economic standpoint, the system possesses the curious attribute of charging purchased pig feed to the vegetable enterprise as the single most important money cost in vegetable production, since mixed pig and vegetable farms need relatively little purchased fertilizer.

A final note on methods of purchasing farm supplies will serve to complete our discussion of productive tasks. Fertilizers and seed appear to be the most important supplies, in terms of cost -- fertilizers alone account for four-fifths of the cash expenses in leaf-stem vegetable production in the plain. Three sources of these supplies are used. The most common procedure is to buy from a supply shop in town; the second most common, in the case of seeds, is purchase from hawkers on the farm, although this procedure is not used for fertilizer purchases, which involve transfer of considerable weights. The second procedure for fertilizers, and the third for seeds, is purchase of the supplies in one of the nearby shops, adjoining the plain. Farmers enter into a complex credit relationship with the shops in town and nearby, one which apparently involves little if any interest payment, but rather a tacit commitment on the part of the farmers to continue trading with the same shop owners, to whom they are usually considerably in debt, and who, we suspect, use the debt, and its effect of tying farmers to the same shop keeper over a long period of time, to increase prices over what would prevail in a completely free market in which adequate capital was in the hands of buyers.

The Productive Time Budget.--The following discussion deals with quantities of labor input, and seeks to build a picture of the relative amounts of time allotted to the major productive tasks, what we will call for convenience the "productive time budget." Unfortunately, the available data are neither complete enough nor accurate enough to permit more than a highly generalized picture.

Two primary sources of data will be drawn on, and attempts will be made to expand what data there are from these sources by assuming that the observations involved represent typical patterns -- always a risky endeavor, particularly where quantities are sought. The first source is the "activity observation" described earlier; the second, detailed questioning on the few "selected farms" visited a number of times during the six months following the major field effort in the plain. Descriptions obtained for three, four, or a half-dozen "selected farms" on the time taken in any given task cannot, of course, be generalized to the plain as a whole, and can merely serve as qualitative illustrations. However, if we assume that the forty-odd farms covered in the activity observation are typical, and that the three records obtained for each hour of the day provide a representative picture of the "average" working day, we can tap the fund of area-wide data on available labor (age and sex distribution of the farming population, and off-the-farm employment) and make some limited generalizations. Throughout the following discussion it should be borne in mind, however, that generalizations rest ultimately on these two rather shaky assumptions.

The first problem we face is to determine the number of times a given task must be repeated during a given period, in this case a year. To do this we introduce the concept of a "mean bed cycle," the average length of time, for all crops (weighted in proportion to the area occupied by each crop), between preparing a bed on two successive occasions for seeding or transplanting. (Since, on the average, one-ninth of the area is occupied by seedbeds, and a residue of seedlings is brought to maturity in the seedbed itself after most seedlings have been removed to the maturing beds, values for the semi-cycle between two successive bed-preparations must be corrected by multiplying them by .89.) The mean bed cycle for the plain is 30.5 days, almost exactly 12 (12.01) bed cycles per bed per year.[5]

[5]Choy sam remains in the seedbed 20 days and in the maturing bed 22 days, on the average, giving 14.8 bed cycles per year (16.6 x .89, the correction factor). All other crops have somewhat longer bed cycles, associated with longer periods of growth in the maturing beds, and the mean bed cycle is therefore slightly longer. It should be noted, however, that the modal bed cycle, i.e., that applying for the eight-ninths of the beds which do not retain the seedcrop, is not 30.5 days but rather 27 days, or about 13½ "crops" a year. For comparison with data presented by those who, like John H. Thompson (1957), choose to measure intensity of production by comparing cultivated area (area times the number of crops per year) with actual area, we may consider Kallang farms to have 13½ times as much cultivated "area" as actual area--a figure so absurdly unreal as to bring into question the usefulness of the concept underlying this ratio.

The average number of beds on Kallang farms is about forty-one. We can therefore compute the number of individual bed cycles on an average farm in a year, the figure being 494, or 1.35 per day. To make this last figure meaningful, we can speak in terms of about one and one-third repetitions of once-per-cycle tasks (bed-preparation, liming, transplanting, seeding, harvesting, etc.) on each day for the average farm, or four repetitions every three days. Since our data are somewhat imprecise, the value one and one-third can be used as easily as 1.35, and is more convenient.

In theory, it should be possible to take each of the separate productive tasks and place it into one or another of the classes of behavioral cycles involved in production. Those tasks performed once, or a fixed number of times, per bed cycle would constitute one such class. Those performed once per <u>crop</u> cycle -- each plant is, after all, seeded, transplanted, and harvested only once in each crop cycle, or for the modal case, once in every two bed cycles -- would constitute another. Those performed daily would constitute a third, and so on. In this way a total picture of the productive time budget would emerge if the time occupied in each task, on the average, were known. Unfortunately, it is not, so we shall have to be content with estimates for certain tasks, and place all remaining tasks in a residual class which will be given a time value just sufficient to raise the total annual time-input to the level determined by other methods, those based on farming population and off-the-farm employment, rather than individual tasks.

From the activity observations, it appears that the daily productive time input for farms in the area observed amounts to about eight hours per adult male full-time participant, six and one-half hours per adult female (full-time or part-time participant), and possibly two and one-half hours per child. We shall have to assume, for the following analysis, that the same time input applies for the entire plain, of which the roughly 40 farms in the activity-observation area form about four-seventeenths. It appears further that, on these forty-odd farms, there are about 35 males working full-time and about 55 females working, for the most part, on a part-time basis. Thus we can compute the total number of man- and woman-hours per day to be, for the area, 280 and 358 respectively, or 7 male and 8.9 female per farm.

Tilling was observed to be undertaken by 39 per cent of the male participants over the three-day activity-observation period. The figure for women was 21 per cent. We shall have to return to the assumption that tasks of this nature are performed by women at half the efficiency of men. On the average farm, men put in perhaps 2.7 man-hours at tilling during a day and women 1.9 "woman-hours," which we convert to man-hours by dividing by two. Thus the computed total time input for tillage may amount to three hours and forty minutes. Since the average farm has 1.35 tillage tasks to perform per day (1.35 bed-cycles per day), each such task would seem to require about 2.7 man-hours. This figure is somewhat higher than that reported by the "selected farms," eight of which reported an average of about one and one-half hours per bed. The data are not sufficient to reconcile these two figures, arrived at by quite different methods of study.

Using data from the activity observations, and employing the method used above to compute time input from these observations, we find that 11 per cent of adult male labor, and 16 per cent of adult female labor, is employed in the tasks of seeding and transplanting. Thus about three-fourths of a man-hour and 1.4 "woman-hours" (which in this case are only slightly longer than man-hours) per farm per day are associated with this task. This yields a figure of 1.6 man-hours per bed. This figure agrees fairly well with the reports given on three "selected farms" providing estimates on seeding and transplanting tasks: Two estimated the time at about one and one-half hours, while one (Ng Hong, who has almost three times the average number of beds, and must work quickly) estimated it at slightly under one hour.

Calculation of time in harvesting poses a special problem, in view of the contribution of children, and the near-impossibility of converting this labor element to adult man-hours. Earlier (Chapter XIII) we stated that, somewhat arbitrarily, we would call a child-hour 8 per cent of a man-hour, and we shall proceed on this assumption. Twelve per cent of adult male labor, 21 per cent of adult female labor, and 48 per cent (by time) of child labor are employed in this task. (Note: Marketing is excluded from these, and preceding, figures, since we are dealing here with time employed in field tasks only.) Since male and female labor can be equated in this task, men and women together contribute about 2.7 man-hours per farm per day. Children contribute about one hour per farm per day, and this adds perhaps another tenth of a man-hour, giving a total of 2.8. With one and one-third beds to be harvested per day, each should require slightly over 2 hours. However, four selected farms providing data on harvesting give an average value of one and one-quarter hours per bed, two estimating it at one hour and two at one and one-half hours. This discrepancy can be plausibly explained by arguing that, since harvesting is carried out late in the afternoon and early in the evening, some farm-family members working elsewhere during the day add their labor to the labor force in the activity-observation area, increasing the total. (Nearly one-third of the male man-hours employed in this task are contributed after 5:00 PM.)

For the remaining tasks, no estimate of time-input per crop-cycle or bed-cycle can be given. We can provide a rough estimate of the time-input per task per day, but this will be dealt with in the following section. The foregoing analysis has, however, covered about two-thirds of the time-input by men and women on field tasks.

Daily Cycle of Productive Activities.--Perhaps the most useful approach to the question of the normal daily cycle of activities, concerning which we have both intensive qualitative information (from "selected farms") and less detailed quantitative information (from the activity observations), would be to present each such class of information separately. Accordingly, we shall begin by quoting interview reports on three "selected farms" in turn; later, a summary of the flow of activities from pre-dawn marketing to late-evening field tasks will be given, largely in terms of percentages of the total time-budget devoted to each task during each hour of the day.

In presenting the following descriptions few changes have been made: Except for minor emendations, the reports are exactly as they were written down by interviewers from field notes taken during the course of their talks with the farmers.

> Farm No. 111: The farmer gets up at 6:00 in the morning, and as soon as he finishes his breakfast the field work begins. The usual practice is that, since the sun is not so hot in the morning, the most strenuous part of the farming activities is done between the hours of 7:00 AM and noon. This includes mainly the work relating to the preparation of beds.
>
> Lunch is between noon and 1:00 PM. After a short rest the farmer goes into the field again. The hours between 1:00 and 3:30 PM mark an important phase in the daily activities of the farmer. Watering, fertilizing, weeding, planting, and transplanting will then be in full swing. It is necessary to emphasize here that no time can be spared during these hours, especially in matters of watering and transplanting.
>
> A short break at the coffee shop at 3:30 PM is not unusual in view of the heat of the afternoon. Field work is resumed after a few minutes, and the farmer finishes the work left behind for the day. This may go on until 6:00 or 7:00 PM, depending on the amount of work to be done. Dinner takes place at 8:00 PM, and this marks the end of the day's work.
>
> It is important to point out that this farmer works relatively less hard than most. In the first place, he is a little bit lame, and consequently he cannot do any of the watering. Moreover, harvesting is done by the buyers and therefore he does not have to pluck and wash the vegetables as others do.
>
> This farm consists of two people, namely the farmer and his mother. The daily activities of the mother are

similar to those of the farmer, except that the mother does all the watering as well as housework whereas the farmer concentrates more on the remaining work.

The description given above is not entirely consistent with what we actually saw at the time of our visit. On two occasions, we found that instead of preparing the bed in the morning, as he told us, he was doing weeding and transplantation. The explanation given was that there were no more land and beds to be prepared and naturally he must occupy himself in other jobs. There is no doubt about the truth in this statement. We therefore conclude that great caution should be exercised in arriving at a definite picture of the daily activities of the farmer. The so-called "average day" is an extremely difficult notion to the farmer.

Farm No. 114: The farmer gets up every morning at about 5:30 A.M. He starts work at 6:00 A.M. and does not stop until around 10:00 A.M., at which time he goes out to the village tea-shop for a drink and a short rest. Six A.M. to 10:00 A.M.: The main work he does during this period is the preparation of beds which have been harvested on the previous evening. This work will take him the whole morning. Sometimes, if there are one or two beds more to prepare, it may take him up to the afternoon; these are rare occasions.

After a short rest, he will start work again at about 10:15 A.M. From 10:15 A.M. to 11:00 A.M., he continues preparing his beds. At 11:00 A.M. he waters his vegetables, which will take up about an hour of his time. At 12:00 noon, he retires for his first solid meal. In name, he rests up to 2:00 P.M., but in actual fact he does some light work during this rest period. Occasionally, he goes out to do some weeding. He says that this time of the day is too hot for any heavy work.

He starts work again around 2:00 P.M. and goes on until around 7:00 P.M. -- sometimes up to 8:00 P.M. Two P.M. to 7:00 P.M.: During this period the work he does includes watering, transplanting, applying prawn dust, spraying derris root water (*Derris elliptica*, a pesticide), harvesting crops, washing them clean and arranging them.

In the afternoons, there are two waterings to be done: One is at 3:00 P.M., and the other is at 5:00 P.M. Crops are usually collected from their beds at 3:30 P.M. to 4:00 P.M. When the vegetable plants are being pulled out, each is carefully stripped of its yellow leaves and graded according to two sizes. Last of all, the vegetables are tied up into bunches of about fifteen *katis* each. These are brought down to the pond or ditch to be washed clean.

In transplanting, he first goes to a bed of seedlings which are ready, and picks out 1,000-odd seedlings for transplanting into one bed. He selects those seedlings which are strongest and which grow too close to one another. When he plants, he digs a shallow hole in the bed with his two fingers, puts the seedlings in, and presses a little soil back to cover the roots. The spaces between the seedlings are just roughly estimated.

At about 8:00 P.M., the farmer takes his dinner, which is his second solid meal. From this time onward, up to the next morning, he does no work in the field.

Two other persons - his wife and his daughter - also work full-time in the field. Early in the morning, at about 3:30 A.M. his wife brings the vegetables out to the Balestier Road market to sell. She comes back around 6:00 A.M. to 7:00 A.M., but he says this is very uncertain. She does all the cooking - sometimes the daughter helps in washing and house-cleaning. He says that the field-work that his wife and daughter do is as important a share as his own work.

Farm No. 148A: The farmer is usually up by 6:00 A.M. and takes his breakfast sometimes at his son's house or at a coffee shop. He'll be at the field at 7:00 A.M.; he works right up to noon, when he takes his lunch. Within this period he usually prepares his beds and waters his crops. The heavier part of this work is done in the morning.

After his lunch he takes a short rest and is back at the field about 1:00 P.M. He will then do some weeding and transplanting. In this case he need not harvest his own crops because he sells his vegetables to a middleman by beds. The middleman will harvest the crops in the afternoon. So most of his time in the afternoon is spent on watering, applying fertilizers, transplanting, and weeding. He stops work at about 6:30 P.M. He cleans up and takes his dinner and rests.

As regards quantitative data on the daily cycle of productive activities, it must be re-emphasized that the "activity analysis" from which these data are obtained covered only three complete days, and the information is therefore of limited value except as an indicator of general tendencies. The hour-by-hour observations were, of necessity, spread over a period of days, twelve in all. While eight of the twelve days were rainless (the modal condition in the plain), two days had falls of two and three inches, respectively; thus, in terms of rainfall, the variable most closely associated with variations in the daily cycle of activities, the period was not normal. In general, it can be said that the data reflect normal activities of drier periods except for morning behavior, which involves more emphasis on watering than the data reveal, since one entire morning of observations occurred after one of the heavy rains.

It appears useful to give figures in terms of the approximate "effort input," with woman- and child-hours converted to man-hours on the basis of estimated relative efficiency, as well as in gross, unadjusted, hours of effort. The conversion to man-hours involved the following adjustment: Children were given a value of .08 man-hour per hour for all tasks except harvesting (the only task in which they figure significantly), in which a value of .50 man-hour per hour was assigned; women were given one man-hour per hour for weeding, harvesting, and fertilizing; .75 man-hour for watering (assuming equal time spent in heavy watering, at .50, and light watering, at 1.00), planting, and miscellaneous tasks; and .50 man-hour for tilling.

In terms of gross input-hours, including men, women, and children on an equal basis, the curve of total time input rises from zero at 6:00 AM[6] to a morning peak between 10:00 and 11:30. There is a steep rise to 8:00 AM, then a levelling off, and finally a sharp decline to a minimum (approximately

[6]Time spent marketing is, of necessity, excluded, since the observers could not obtain these data on the same basis as data on field activities, where direct visual observation and frequency counts were employed.

half the maximum morning input) during the lunchtime and resting hours, 11:30 to 1:30. The drop to half substantiates our view that a one-hour interval is normal for the noontime break.

During the afternoon, a steady rise takes place, to the day's peak between 4:00 and 5:00 PM. From that time on labor falls off, with very little work taking place in the fields more than two hours after sunset.

The afternoon peak largely reflects the increased field work of women and children. The heaviest input of time by men occurs in the morning, between 10:00 and 11:30; in fact, there are three morning hours and three afternoon hours when male labor is at or relatively near the peak (very approximately two-thirds of a man-hour per hour per farm). The labor of adult women does not exceed that of men, in terms of time as well as efficiency, in the morning; in the afternoon it rises to a time-input level double that of men during the peak afternoon hour. Children contribute a significant amount of time, in harvesting for the most part, after 3:00 PM. At the time of the morning peak, roughly 49 per cent of the time input is adult male, 47 per cent adult female, and 4 per cent child. For the afternoon peak the figures are 27 per cent, 55 per cent, and 18 per cent, respectively.

No significant difference appears, in reference to the periodicity of over-all field labor, when we use adjusted rather than gross input figures. The peak times remain the same. Most important, perhaps, is the much greater importance of adult male labor during the morning hours.

The peak hour for watering is between 11:00 and 12:00 in the morning. Significantly, the level of effort input remains high throughout the noon hours, only falling off after 4:00 PM, but then rising to a lower secondary peak between 5:00 and 7:00 PM. There is also a secondary peak between 9:00 and 10:00 AM, followed by an hour of less intensive watering. The drop between 10:00 and 11:00 is assumed to reflect the increased attention given to bed-preparation activities after the first watering; the late-afternoon peak appears to reflect the need for raising soil moisture to a high level for the nighttime period of relatively low evaporation but no watering.

The peak for tillage operations is between 10:00 and 11:00 AM. Effort input rises rapidly between 6:00 and 8:00, then levels off to a plateau lasting until 11:00. A drop occurs during the period 11:00-12:00, with a secondary maximum (only one-third the morning maximum) occurring between 1:00 and 2:00 PM.

Planting operations, on the other hand, have their maximum effort input in the late afternoon, the peak occurring between 4:00 and 5:00. There is a secondary peak in the morning, between 8:00 and 10:00, but it is only one-fifth the afternoon peak. The first significant hour for planting in the afternoon is 1:00 to 2:00 PM; a rise occurs until 3:00, after which planting is near the maximum until 6:00.

Harvesting becomes important only after 3:00 PM. The peak occurs between 4:00 and 5:00, at which time more total effort is being devoted to this task than to any other at any time of the day, a result, largely, of the added contribution of women and children.

The peak in fertilizing occurs even later, between 6:00 and 7:00 PM, reflecting the farmers' feeling that prawn dust burns the plant leaves if applied when the sun is hot -- a belief we tend to question, but could not check. As with other tasks, there is a minor secondary peak in the morning, only about one-fifth the afternoon peak. The first significant hour for fertilizing is between 3:00 and 4:00 PM.

Weeding, finally, reveals itself as being more significant in terms of total effort input than would be suspected from farmers' accounts of farming operations. Apparently the task is undertaken irregularly and for short intervals, but, in total, it represents a significant input of effort, greater during its peak hours (maximum: 10:00 to 11:00 AM; secondary maximum: 4:00 to 5:00 PM) than the peak-hour input for watering, for planting, and for fertilizing.

Measured in terms of efficiency, the total contribution of adult males shows itself to be considerably greater than when measured by time input alone. Measured in terms of time, adult males contributed only 37 per cent of total labor. After adjusting for efficiency, their contribution rises to 46 per cent. On farms where non-farm employment is not significant, of course, it becomes much greater.

CHAPTER XVII

ELEMENTS OF CROP ECOLOGY

Introduction: the Derived Micro-environment.--In Chapter IX it was pointed out that the concept of a "natural environment" hardly has meaning in the context of Singapore smallholder agriculture. This is particularly true for Kallang farms, where nearly all environmental factors in crop ecology are strongly altered by productive behavior. In the present chapter we shall discuss the end-product of this process of altering the impact of environmental factors, the ecology of the plants themselves.

By "derived micro-environment" we mean the actual habitat of the crop-plant. This is made up of two sorts of elements: environmental factors such as micro-climate and soil solids, which affect the plant in a manner strongly influenced by productive behavior; and materials, notably crop nutrients, added to the ecosystem by the farmer. As we shall see, the total system consisting of crop and derived micro-environment is so complex and "unnatural" as to suggest hydroponics rather than field agriculture.

Soil Moisture.--Three possible sources of moisture are available to crops in Kallang beds: rainfall, hand-applied water, and moisture supplied by capillary action from the water table. Rainfall in the plain averages about ninety-five inches per year. Hand-applied water may average in the neighborhood of fifty inches a year, on the basis of very limited data.

The average amount of hand-applied water for Ng Hong's farm was computed as about thirty-six inches a year, by measuring the volume of his watering buckets and determining the number of bucketsful applied under various conditions of cloudiness, rain, etc., as well as the average for all days -- in both cases using his own recollection as the source, since we could not observe the tasks over a long period of time. Calculations were also ventured on two other "selected farms," one giving a value of 90 inches per year and the other a general range of between 25 inches and 40 inches. There is reason to believe that Ng Hong's figure is below the average, since he finds it difficult to supply what he considers optimum watering for his unusually large number of beds. The 90 inches value was obtained on a very small farm, where available labor is high in relation to cultivated area. On 168 farms questions were asked concerning the amount of water (number of bucketsful) applied to one selected bed of vegetables, about which an array of special qualitative questions of all sorts was asked. The questions on watering were: (1) How many loads of water were applied to the bed yesterday (the date being known)? (2) How many loads are applied on a rainless, sunny day? (3) How many loads were applied before planting? Unfortunately, the number of variables operative was so vast that few meaningful data emerged. Among the variables were: poor recollection; stage of plant growth; variability; type of crop (relevant for certain of the crops). Had we had enough reports, multiple correlations, taking into account quantity application, rainfall, perhaps cloudiness and evaporation, stage of plant growth, and crop type, would have proved fruitful. But 170 reports cannot be subdivided this many times, if variability and error are high enough to produce significant scatter in any case. At this point all we can present in the way of data from the questions asked on one specific bed per farm is the estimated quantity of water applied to each such bed under choy sam (representative of almost all the area under crops) on a rainless, sunny day: The figure may be roughly the equivalent of one-fourth inch of rain. The figure has little value without comparable, paired, data for evaporation, soil moisture, and depth of the water table. Thus we are left with the three annual estimates -- 36 inches, 90 inches and 25-40 inches. Thirty-six inches seems too low, and 90 inches too high. The mean, for what it is worth when based on three values, only one of which (Ng) is reasonably reliable, is 53 inches. Farmers' memories would tend to stress recent conditions, so the fact that rainfall was higher in the plain during the first half of 1952 than is normal should be taken into account, suggesting that the value is higher than 50 inches as a mean for the plain. We call it 50 inches only to stay on the conservative side. A rough check on this value is provided by multiplying the hand-watering value for dry, sunny days by the number of rainless days in the plain in 1952. The total is 51 inches. Using mean values for the near-by Kallang airport, 181 rainless days, the total is 41 inches.

The role of the water table in supplying water to plant roots appears to be slight. On the other side of the ledger, no data are available on water use for these vegetables under equatorial conditions and high fertilization; evaporation data are applicable to the island as a whole rather than the plain; potential evapotranspiration measurements for other parts of the tropics (Trinidad, Yangambi, Ibadan) are not strictly comparable on account of differing rainfall and evaporation regimes, and in any case make use of grass rather than short-term vegetables;[1] and computed potential evapotranspiration does not agree particularly well with measured PE under equatorial conditions.[2] Thus the water budget for Kallang vegetable beds cannot be computed.

However, some of the parameters can be roughly sketched in. First of all, it is clear that, hand-watering apart, there is a strong water surplus in the plain. Watts (1955:62) supplies seven-year evaporation data from three-inch evaporimeters at three locations in the interior of the island; these

[1]Cf. papers by Smith, Garnier, Mather, and Ramage in Mather (1954). Only Ramage supplies comparative data for vegetables and grass, but his apply to Hong Kong in fall.

[2]Cf. discussions in Mather (1954).

yield a value, which we should treat as simply an approximation, of 64 inches a year, or 31 inches below the annual rainfall in the plain. According to the data cited by Watts, in only one month (July) is evaporation very slightly above rainfall in the plain; in June it is one-half inch below rainfall; and in all other months rainfall exceeds evaporation by from one to five and one-half inches. Thornthwaite's formula leads us to a value for annual potential evapotranspiration of about 1730 mm. per year, well below the annual precipitation of 2413 mm.

From the foregoing it would seem to follow that hand-watering is unnecessary under Singapore conditions, except possibly in July (when potential evapotranspiration is 149 mm. and rainfall 128 mm. -- in all other months rain exceeds potential evapotranspiration. Such is evidently not the case, and an explanation for hand-watering -- an attempt to assess its ecological role in Kallang vegetable farming -- must be ventured. To do this, we must first examine some of the properties, both natural and artificial, of vegetable soils in the plain.

Soils of the Lower Kallang Plain are, for the most part, heavy in texture, structureless (below the zone of cultivation), and waterlogged to within two feet of the surface.[3] These _glei_ soils possess no visible differentiation of horizons,

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[3]The "surface" here means an imaginary plane drawn through the beds at the level of the bordering paths; cultivation within the beds does not extend below this level.

and give way to a humic, essentially peaty, substratum at a depth ranging from one to perhaps three feet. For all crops other than those which grow in saturated soil or standing water (e.g., rice and jute), these soils would normally be considered distinctly unwholesome.

With the exception of zones bordering the plain on either side, adjoining the low bluffs, soil types within the plain vary rather little except in depth of the water table and the humic layer. The physical character of these soils can best be described by means of a composite profile description, such as the one given below. In it, the following characteristics are described: texture, structure, moisture relations, color, and organic matter. These are given for rather arbitrary depth-units, since no visible horizons occur in this soil. The profile is a composite of all samples examined throughout the central portion of the plain.

Depth	Character
0-4 inches	Texture: Clay to silty clay, subject to moderate shrinkage. Structure: Hard, granular to nut, probably very unstable (due to frequent saturation from rainwater accumulation). Moisture Relations: Rarely dried out, and frequently saturated for short periods. Color: Dark to greyish brown. Organic and Foreign Matter: Decomposed and decomposing vegetable matter from past cultivation; charred organic particles and baked, red clay nodules from the "burnt earth" added to the soil.

5-8 inches	Texture: Similar, though often more clayey. Structure: Dense, blocky to massive; often structureless. Moisture Relations: Probably above wilting point at all times and frequently saturated for hours or days. Color: Medium grey-brown to dark brown, with rusty to ochre-yellow mottling in some areas. Organic and Foreign Matter: Same as above, but less pronounced.
9-12 inches	Texture: Similar, though often more clayey. Structure: Usually massive, structureless. Moisture Relations: "Sticky point," indicating the level below which the soil is normally saturated, occurs in this zone in some profiles. Color: Medium grey, blue-grey or greyish-brown, with much rusty to ochre-yellow mottling. Organic and Foreign Matter: Usually little evidence of either, though some remnants of "burnt earth" remain.
1-2 feet	Texture: Similar; usually a plastic clay, sometimes containing loose concretions. Structure: Massive, structureless. Moisture Relations: "Sticky point" will be reached in the upper portion of this zone in most areas, usually above 20 inches depth. Typically waterlogged from above 2 feet. Color: Dark brown (organic-stained), medium grey-brown or bluish grey, with some mottling. Organic Matter: Most profiles show more or less muck at this depth, sometimes including partially-decomposed woody matter.
Below 2 feet	Texture and Structure: Similar to above. Moisture Relations: Waterlogged in all profiles examined, with water rising quickly to 24 inches or higher in bore-holes. Color: May be bluish grey or deep brown, depending on amount of muck present. Organic Matter: Similar to above.

From this description several facts of considerable importance for an understanding of soil moisture relations emerge. For one thing, with sticky point rarely as deep as two feet, texture extremely heavy, and structure essentially non-existent, seepage downward of moisture added to the surface (from whatever source) is slow. If we ignore the disturbed soil of the beds, and the occasional nodules of burnt earth or charred organic matter found in the uppermost portion of the profile, we can offer the following additional generalizations: (1) The water column between water table and surface is uninterrupted, allowing movement of water upward by capillary action; (2) however, any such movement must take place at a very slow rate; (3) the clayey nature of the soil results in a sealed surface zone during all but the gentlest (and rarest) rains, since downward percolation through the soil cannot keep pace with the addition of rainwater at the surface; and (4) fluctuations of the water table should be slow, and, in view of the relatively uniform rainfall regime from month to month, not very pronounced in amplitude.

Soils along the marginal belts need not be described in like detail since, for reasons which will shortly become obvious, they are cultivated much less intensively. The eastern margin of the plain is given over for the most part to non-agricultural uses; the western margin can be described as potentially cultivable to, and beyond, the break of slope. However, as one approaches the western edge of the plain, two important changes take place in the soil: It becomes sandier, grading from sandy clay into sandy loam; and the water table rises to within a foot of the surface (in some places to the surface itself). Most of the objections which Kallang farmers have to a sandy soil will be discussed later in the chapter; here we may note simply that a sandier soil is subject to much greater fluctuations in the water table and greater flooding. The typical profile not far from the break of slope looks something like the following:

Depth	Character
0-9 inches	Texture: Sandy clay. Structure: Loose or nonexistent. Moisture Relations: Saturated at about 9 inches, on the average. Organic Matter: Considerable muck. Color: Dark brown.
Below 9 inches	Texture: Sandy clay. Structure: Massive. Moisture Relations: Saturated; water rises rapidly in bore holes to about 9 inches. Organic Matter: Highly humic; almost pure muck at about 18 inches. Color: Dark brown.

Given these characteristics, it is easy to see why these soils are cultivated much less intensively, and tend to be used for non-leaf-stem vegetable crops. The beds are built to heights of as much as three feet to avoid root-drowning, and the upper surface of the beds is flattened, sometimes even made concave, to reduce surface runoff.

Let us turn now to the soils of the beds themselves, those found in the clay-soil zone dealt with earlier. Anticipating the discussion which follows in later sections of this chapter, we may summarize the factors which serve to provide the zone of cultivation with moisture relations almost completely different from those of the subsoil. First of all, extremely careful tillage breaks down the massive, structureless material into small "pseudo-aggregates," neither so large nor so well compacted as to interfere with root ramification, to interfere with downward and sideward percolation of free waters or to permit any considerable amount of upward movement of capillary water. Secondly, the addition of considerable quantities of organic matter results in the wholesale production of soil-binding mucelages, presumably similar in function to those produced under conditions of normal humus formation. These are of extreme importance in soil aeration; regarding soil moisture relations, they assist in holding larger quantities of water in the zone of cultivation than would otherwise be the case, in part by encouraging a looser micro-structure, and they strengthen and stabilize the "pseudo-aggregates" formed by tillage. Thus, the soil of the beds possesses the artificially provided equivalent of good structure and high organic matter, with all that these imply in assisting to open up the soil both to air and water. Clay soils with good structure retain more capillary water, in proportion to weight, since pore spaces are both more extensive and more closely interconnected. What is more important, roots are able to penetrate such a soil very much more easily than they can an essentially structureless, massive clay, so that what capillary water exists is considerably more accessible to the plants; this is particularly important for the fast-growing vegetables, whose root-systems are never very extensive and, in any case, have little time to spring apart the aggregates of clay if they are not already separated. In addition to the foregoing, the farmers' action in "roughening up" the surface by tillage allows a greater proportion of water intake as against runoff, by comparison with an undisturbed clay: In the latter, the absence of entry-ways into the soil results in a rapid sealing of the surface and greater runoff, sometimes even before the soil pore-spaces have been filled at depth. In sum, the combined effect is to produce a soil possessing rather good moisture relations, in contrast to the original massive clay, whose moisture relations are extremely unfavorable for vegetables.

However, the Kallang clays should not be viewed as approaching the ideal in moisture relations. First of all, the shallowness of the beds, below which is a relatively sharp line of separation followed by an extremely dense and largely impermeable subsoil, limits the volume of soil available both for water-gathering by roots and for water storage. Rainwater entering the bed first brings the soil up to field capacity, of course, after which the additional free water percolates downward to the bottom of the zone of cultivation, then laterally outward to the bordering path, thus becoming lost to the plants.
A deeper soil would possess higher water-storing capacity and thus greater resistance to droughts; the break in the water-column and the nearly impermeable subsoil prevent the high moisture content of the subsoil from providing much relief in this connection. A second difficulty results from the instability of the "pseudo-aggregates:" It is a truism that

tillage opens up the soil, but the extremely high proportion of total effort devoted to this set of operations in the plain should properly be "charged" (if we were to set up an accounting system in which crop-ecological "returns" were assigned labor "costs") in large part to the need for rebuilding soil properties relating to moisture and aeration; the high labor input here largely reflects the importance of good air and water relations, and the importance of maintaining a "pseudo-structure" to this end.

It is in the matter of remedying water loss through percolation and runoff that the chief significance of hand-watering is to be found. Seen from another viewpoint, the factors of runoff and percolation appear to account for the previously discussed imbalance between moisture supply from rain and moisture loss through evapotranspiration, and, in addition, to sufficiently increase the deficit as to require a supplementary source of moisture to redress the balance. Upward capillary movement from the water table cannot provide much assistance, for two reasons: First, the rate of supply is low; and second, those few roots which can penetrate to the upper surface of the subsoil can feed only on this surface -- penetration below this point would seem to be extremely difficult, and was not observed to take place.

Dr. Garth Voigt of the School of Forestry, Yale University, has called the writer's attention to a relevant Dutch study of upward capillary movement in clay soils (Wind 1955: 60-69). The soil mineral fraction is 60 per cent clay and

40 per cent silt; the water table, during the experiment, lay at a depth of 45 cm. Upward capillary movement to the root zone over a 98-day period totalled 153 mm., or about 1.5 mm. per day. The results of this investigation suggest that values for such movement in Singapore should be much less than the 1.5 mm. per day value, since, although the water table and textural data are comparable, no interruption of the water column appears to have been present in the Dutch soil investigated, whereas the break between the disturbed bed-soil and subsoil in the Kallang plain constitutes such an interruption. In the study referred to, grass roots assisted in providing a moisture deficit down to a depth of about 10 cm.; in the Kallang plain the roots appear not to penetrate the subsoil, and we can assume little if any evaporation sink at the lower margin of the beds to fulfill the same function.

In terms of the total water balance, hand watering is thus the factor which, at least in part, overcomes the deficit produced by sideward water loss to the paths, and ultimately the ponds, the drains, and the river. Unfortunately, since we did not measure this sideward flow (and, in any case, produced only a rough approximation of supply through hand-watering), the water budget cannot be computed. Qualitatively, however, the significance of hand-watering can be explained, on the basis of the information given above on soils, rainfall, and, earlier, behavioral features of the hand-watering process. To do this we must first give some further consideration to potential evapotranspiration.

Thornthwaite's formula for potential evapotranspiration has not as yet proven itself to be particularly useful as a means of estimating precisely the daily or monthly water loss to the atmosphere near the equator. Checked by Hardy and Smith for Trinidad and by Garnier for Nigeria (Mather 1954), the computed PE values appear to be higher than measured PE values during the wet season in these respective areas, and Singapore's climate is similar to the wet season in each of these localities (particularly the former). Measured PE for both areas seems to lie at about 100 mm. per month during the months which are similar to Singapore's climate, in terms of rainfall, humidity, and cloud cover. We should thus expect PE to lie in the neighborhood of 1200 mm. per year for the plain. However, the studies by Hardy and Smith and Garnier employ tropical tall grass as an indicator, and we are dealing here with vegetables. Ramage, in Hong Kong (Mather 1954:115), experimented with Chinese cabbage to determine the ratio of PE for this crop to that for grass. Unfortunately, his test ran through only one twenty-four-day crop cycle. The results showed Chinese cabbage to have 1.6 times as high PE as grass during the same period. He remarks, however (115), that the rather strong winds obtaining affected PE for the vegetable more than the grass, in proportion to leaf area, and believes the ratio to be too high.

The computed annual PE for Singapore of 1730 mm. should, perhaps, be reduced to about 1200 mm. to put it in line with empirical values for other intertropical stations, but should then be raised again if vegetables do, in fact, have PE of roughly one and one-half times that of grass. It should be borne in mind that both of these correction factors are highly speculative -- the first because we are attempting to compare Singapore with two dissimilar equatorial climates, the second because we are using one very limited bit of experimental data. In spite of the above difficulties, we are forced to employ a figure for PE in the Kallang Plain, and we had best assume, for the moment, a value of about 1730 mm. per year.

The difference, then, between rainfall and estimated PE is about 700 mm. a year; adding our rough estimate of hand-watering (50 inches or 1270 mm.) we obtain an annual water surplus figure of 78 inches, nearly 2000 mm. Even this value should, presumably, be raised by an unknown (though slight) amount to take into account upward movement of capillary water to the bottom of the root zone in vegetables. (The result is not affected materially by water held in vegetable tissues and removed in harvesting: This appears to amount only to the equivalent of one-half inch of rainfall per year.

The only possible means of disposal for this extreme surplus of water lies in percolation and runoff. The paths bordering vegetable beds receive the laterally seeping water and convey it to farm ponds and drains. Here, of course, it becomes available for re-use, via hand-watering. Cultivated acreage averages only two-fifths of total farm acreage; if, therefore, we assume that as much runoff water from non-bed portions of the farm as from the beds themselves, area for area, ends up in the ponds, two and one-half times as much water is available for hand-watering as derived originally from the beds.

However, if potential evapotranspiration is less than rainfall, and rainfall is evenly distributed throughout the year, why is hand-watering needed? The answer appears to lie in either or both of the following: PE may be substantially higher, for the year as a whole, than we have estimated; and only a rather small fraction of total rainfall may qualify as effective rainfall. Most likely both are involved; in any case, either taken alone would allow the same functional significance for hand-watering.

The possible effect of crop type on potential evapotranspiration, i.e., on water use when moisture conditions are optimum, seems still to be an open question (Mather 1954). Even if crop-type has no effect on PE, it seems clear that fertilization does (ibid.,192). (In fact, Ramage's high values for cabbage in Hong Kong may be due simply to this factor.) High fertilization increases the rate of growth of vegetables, and thus the rate of water use during that phase of the growth cycle permitted the plants in Singapore (forty days for choy sam, which takes about sixty days to seed). Further, spacing of the vegetables is very close in the plain, and, while careful study might reveal some root-crowding, it would seem that the rate of water use is increased by the high density of plants combined with supply of proportionally more fertilizer to the larger number of plants and root-systems. If the yield rate of vegetables is any indication of rate of water use, as it must be, the extremely high yields in the plain would indicate PE values much higher than would otherwise be obtained. However, while it is not inconceivable that the high rate of fertilization, high plant density, and large production of green matter per unit of space and time might raise the value for water use to a PE level of some 3300 mm. per year -- the total of hand-applied water and rainfall -- this seems much too high in view of the measurements in Trinidad, Nigeria, and the Belgian Congo. Furthermore, it seems quite inconceivable that actual evapotranspiration could attain this level, in view of the low water-storage capacity of the beds, and the observed runoff.

Probably more significant as a factor in explaining the imbalance between water input and water use, and therefore in establishing an ecological function for hand-watering, is the imperfect correlation between rainfall supply and evapotranspiration, the factor of "rainfall effectiveness." This is a function of several factors, among them the following: rainfall periodicity and intensity, water storage capacity of the beds, and periodicity of evapotranspiration.

Drawing on work by Wells in Queensland dealing with the effectiveness of various categories of rain-shower, Hardy (n.d.) estimates that only one-third to one-quarter of the annual fall of seventy-one inches at the Imperial College of Tropical Agriculture in Trinidad can be considered effective. This low percentage is a result of the fact that light showers evaporate before significantly wetting the soil and reaching plant roots, while heavy showers lose much of their potential effectiveness in runoff after soil interstices have been filled -- or, even more, where sealing of the soil surface results in incomplete saturation before the remainder of the shower is lost in runoff. Only medium-range showers are considered to have a wetting effect approximately equal to the total quantity of rain supplied, and, even then, only when the showers are relatively brief. Thus two forms of rain shower which are very common in Singapore, intense, brief showers, and rains lasting over a longer period of time and supplying more water than the soil can absorb, are conspicuously wasteful. Particularly important in this regard is the low water-storage capacity of the Kallang vegetable beds. It is not unreasonable to suppose that over half of the annual fall in the plain is ineffective. This would bring the annual rainfall supply down to the order of magnitude of PE, or even lower.

A second factor to be taken into account is the periodicity of PE in relation to that of rainfall. Both evaporation and transpiration are at a maximum when insolation is high, assuming high moisture content of the soil; this is also the condition best favoring plant growth. On the other hand, the periods during which the soil is above field capacity, during and immediately following a rain, are periods of depressed PE, since the evaporation sink is much less intense. Thus the peak in PE does not coincide with periods of rainfall. As an illustration of the poor phasing of the two, we may assume a rainfall before dawn on a given day in the plain, providing more than enough moisture to saturate the soil, and consider what happens in the vegetable bed. First of all, a fraction of the rainfall will run off onto the bordering paths, and ultimately to the drains and ponds. The remainder consists of one fraction which will percolate rapidly downward and then laterally to the paths, and another which will remain for a time in the soil, providing it with an initial moisture content equal to field capacity. As the sun rises, evapotranspiration increases, and soil moisture shortly begins to fall away from field capacity. Evaporation takes place in the upper inch or so of the three-inch-deep bed, and, as soon as free water has drained away, roots begin to remove capillary water from the lower portion of the zone of cultivation. If sunlight is uninterrupted, farmers assured us, plants begin to "feel the need for water" by 10:00 or 11:00 AM.

This situation and variants of it which also allow a soil moisture content up to values at or near field capacity at dawn, seem to be reasonably typical of conditions in the plain. For this set of circumstances we can supply some rough quantitative calculations. Potential evapotranspiration, according to Thornthwaite's formula, averages about 4.7 mm. per day in the plain. If the beds are at field capacity at dawn of a given rainless day, and Thornthwaite's PE value applies, and (as is probably the case) most of the 4.7 mm. is lost during the daylight hours, the soil may have dropped in moisture content by perhaps 4 mm. by sundown. The agreement between this range of loss and the farmers' estimate that, on a rainless, sunny day, about one-quarter inch of water -- 5.9 mm. -- is hand applied, is fair; it improves when we consider that PE should probably be higher than 4.7 mm. on a rainless day, as we have indicated in the preceding discussion, and when we further consider the loss by immediate evaporation of the hand applied water. (It is worth noting that Hardy and Smith recorded an average daily PE of 6.0 mm. for the sunniest month during their study in Trinidad -- Mather 1954:130.)

We can summarize the argument as follows. Taken on an annual basis, or even on a monthly basis, rainfall exceeds evapotranspiration by a substantial amount (except in July). But rainfall is far from being totally effective: Much, perhaps most, runs off during heavy or relatively prolonged showers, while an additional sum percolates out of the beds onto the adjoining paths. Thus the apparent budgetary surplus is considerably reduced: We must compare effective rainfall rather than total rainfall with PE, or, put differently, we must debit the water budget for runoff and for percolation out of the beds. In addition, the low storage capacity of these shallow beds, underlain by a partial, or perhaps nearly total, break in the water column, means that periodic deficits occur, and farmers cannot wait for these to average out, since vegetables need constant, high, available moisture.

In this context the significance of hand-watering becomes clear. Watering serves to replenish soil moisture during periods, often measurable only in hours, when soil moisture is dropping considerably below field capacity. Temporary wilting may not occur after a single day of evapotranspiration uncompensated for by watering, since water intake would presumably remain high so long as soil moisture stayed well above wilting percentage. But the farmer's time budget allows only a specified number of hours to be devoted to watering, and doubling-up watering on a given day for the average farm would require time needed for other daily tasks -- harvesting, preparing beds, planting, transplanting.

There are other reasons why watering must take place and at a high rate inversely proportional to PE. For one thing, Kallang farmers are forcing vegetables at maximum growth rates, and any slowing-down of production can be translated directly into a loss of income. Soil moisture need not drop to or near wilting percentage before water intake and growth slow somewhat. If the danger of such a slowing-down exists, the critical time to prevent it is during the period of maximum insolation, when growth is fastest if water is at optimum levels. Secondly, the quality of vegetables is important in relation to saleability, and a reduction in leaf quality follows a reduction in water intake, even if the latter is not sufficient to harm the plant.[4] Third, watering definitely serves to reduce soil-surface temperature, and this may be important as well. In the case of seedlings it is, in fact, critical, although the question is obscure for more mature plants. And finally, it is possible that the extremely high rate of application of prawn dust may, on dry days, result in temporary deposition of toxic salts, which watering

[4]I am indebted to Dr. Erich Bordne, of the Department of Geography, Yale University, for the suggestion that leaf quality is a factor to be considered.

removes.[5]

As a postcript to the discussion of soil moisture, we might observe that hand-applied water differs considerably in quality from rain. First of all, it is subject to greater percentage loss through initial evaporation (much of it from the leaves on which some of the hand-applied water falls).[6] Secondly, hand-applied water does not seal the soil surface as do the most violent showers. Third, it is not applied in a quantity much greater (if any) than is needed to bring the soil back to field capacity, and thus little (if any) is lost through percolation. Fourth, it is applied too gently to harm the rather delicate plants, whereas rain quite frequently damages the plants. And finally, hand-applied water comes at a time when insolation is high; it is inversely correlated with cloudiness and reduced insolation, while the opposite holds true for rain; thus it serves to maximize photosynthesis and growth. Figure 3 illustrates this relationship in a general way. In it we compare the number of observations of men and women watering on each hour over three (non-consecutive) days in August, 1952, with per cent of possible sunlight (mean of August, 1950 and 1951) and mean hourly temperature (mean of August, 1950 and 1951). The limited number of observations on watering makes it impossible to draw any definite conclusions from the relationships shown, but certain general patterns

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[5] I am indebted to Dr. Voigt for this suggestion.

[6] The water is applied at a low angle, possibly to reduce interception by leaf surfaces.

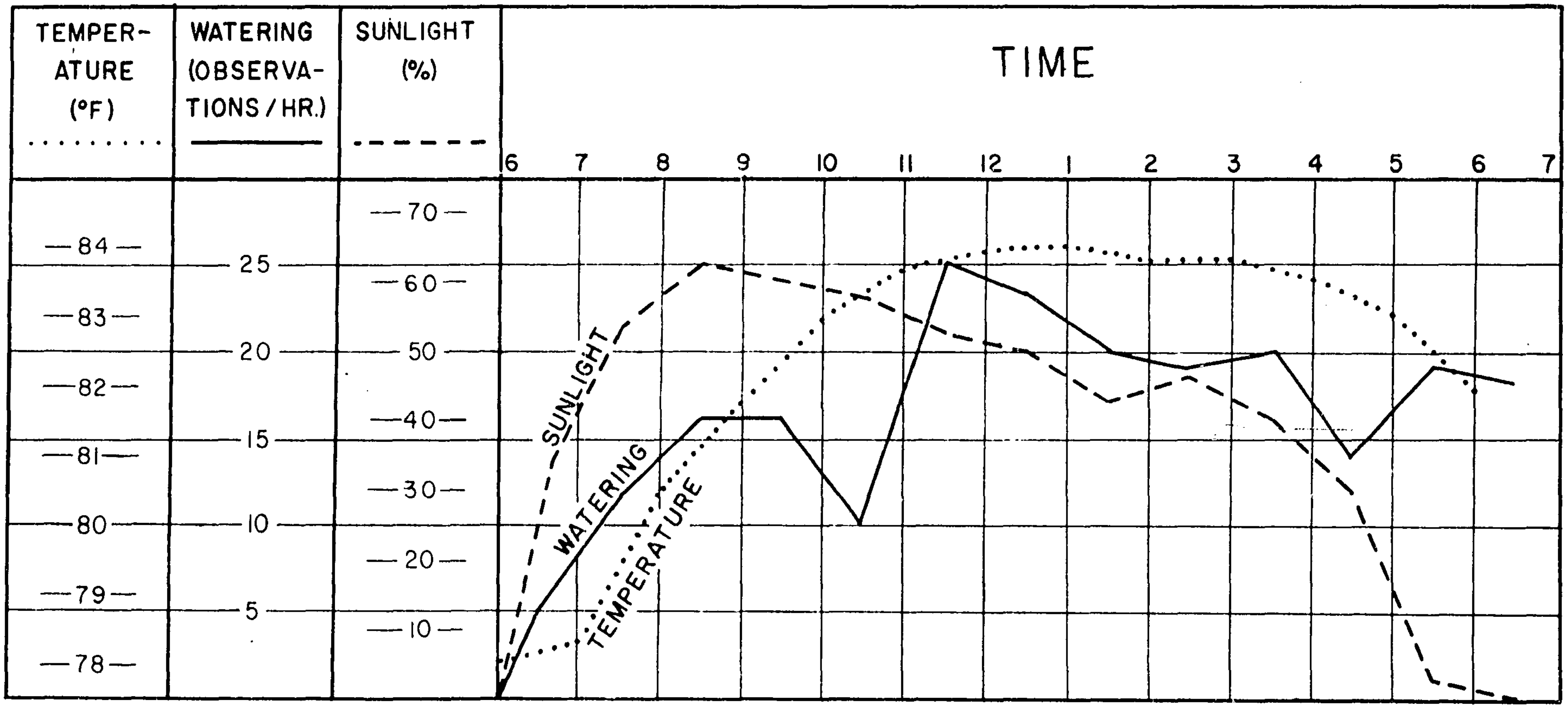

Figure 3. Diurnal Cycle of Hand-Watering of Vegetables Compared with Sunlight and Temperature, Lower Kallang Plain. (Source of data on sunlight and temperature: Malayan Meteorological Service 1951, 1952.)

emerge. First of all, the peak in hand-watering follows that of sunlight. Secondly, whereas sunlight falls off steadily after 8:30 AM, the curve progressively increasing in slope, the descending phase of the watering slope is much shallower. Third, the peak in hand-watering precedes the peak in mean temperature. Relative humidity, not shown, declines steadily from a high of 90 per cent at 6:00 AM to a low of 73 per cent at 3:00 and 4:00 PM, the minimum following the temperature maximum by two hours. (Values given are means for August, 1951 and 1952.) In a general way, it appears that hand-watering on the three days of observation, none of which had rain, was proportional to a resultant of these three curves: per cent of possible hourly sunlight, mean hourly temperature (which of course tends to mirror computed PE), and relative humidity (though not vapor pressure). The anomalous values for hand-watering at 10:00 AM and to a lesser extent 9:00 AM are explainable in terms of competing tasks: This is the period when tilling of beds is in full swing, and one suspects that farmers put the latter task at this time of day so as to have more time from 11:00 AM onward for watering and, later, the afternoon tasks such as planting and harvesting.

Soil Air and Root Room.--The reader may be wondering at this point why Kallang farmers go to considerable trouble to build a soil which is so highly vulnerable to drought (if we may use the term), and thus requires such a high level of attention to maintain soil moisture. The principal explanation appears to lie in a second critical crop-ecological element: soil aeration. Under natural conditions, the clay and silty clay soils of the plain suffer from extremely poor aeration. At depths of one or two feet, mottling -- an indicator of alternating soil air conditions -- begins to give out in the typical profile, and a concolorous plastic clay, ranging from bluish grey to deep brown (due to organic staining in at least some of the profiles examined), appears. At this depth the soil is permanently wet, and root-drowning would be the normal state of affairs. Drainage still qualifies as impeded up to a level rarely deeper than six inches. Even at this depth, it is the foreign matter in the soil -- particles of burnt earth, charcoal, rootlets, and the like -- which appear to provide ingress for air, rather than the rather massive soil mineral matter itself.

Only in the beds is drainage free and aeration adequate for vegetable roots. Here, of course, the permissive factors are all culturally provided: frequent tillage, addition of large quantities of organic matter, addition of burnt earth (which is quite absorbent), and building up the bed above the soil surface, which is frequently wet and not infrequently subject to floods with standing water of an inch or so above the paths.[7]

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[7]Floods up to, and even higher than, this level occur frequently enough to have a significant effect on annual yields. On Ng Hong's farm, one of the better-drained ones, two such floods occurred during 1952, each reducing the yield of crops then standing to about half. Toward the margin of the plain, where the normal water table level is higher and fluctuations more extreme, flooding and consequent root-drowning are even more common.

One of the principal functions of added organic matter is the building of an artificial soil structure, and the chief value of structure here (as in most other places) is in assisting aeration. It can be stated with confidence that soils as heavy as the Kallang clays would be useless for leaf-stem vegetable production if no such open structure existed; tillage alone would not open the soil sufficiently, since the clods would fuse rather rapidly unless held in an open matrix by products of organic breakdown.

Not only are conditions below the zone of cultivation generally anaerobic (during at least part of the year in the upper eight inches; most of the time below one foot), but they are not conducive to root ramification, as we have seen in the preceding section. It seems most unlikely that vegetable roots can penetrate the subsoil itself, except in rare instances. Tillage and added organic matter, plus the minor (?) effect of burnt earth, serve also to provide lebensraum for the plant roots, allowing them access to both water and nutrients without sacrificing adequate aeration.

Probably the chief significance of tillage operations is to be found in the conjoint factors of soil aeration and root room. This statement would hold true in many other farming areas, but here the need for frequent and careful tillage is extreme, since the soil would be unsuitable for leaf-stem vegetable cultivation without it. While adequate soil aeration combined with root room is only one of the "necessary conditions" for the farming system with which we are dealing, it is perhaps the most critical of such conditions, if we measure each on a scale based on labor input.

Soil Nutrient Supply.--Chemical analysis of Kallang plain soils was not undertaken in the study being reported here, but three key characteristics can be assumed. First of all, the soil is highly acid in its natural state, as a result of the prevalent anaerobic conditions and the humic subsoil. Secondly, no matter how rich the soil may be in plant nutrients, the natural release of nutrients could not satisfy more than a small fraction of the needs of the vegetables grown on farms in the plain, in view of the high yields obtained. And third, the fact that the index of texture is high, and the clays are apparently not entirely "lean," means that loss of nutrients through leaching will be much slower than would otherwise be the case. We might also add the fact that the structure provided by tillage and organic fertilizers assists in making soil nutrients available to plant roots.

The importance of maintaining structure seems to underlie the almost total reliance on organic fertilizers, as against artificials, in the plain. Attempts by the government to persuade farmers to turn to artificials had, in 1953, met with no success, in spite of the much lower cost of the latter. Farmers spoke of a "hardening of the soil" which, they claimed, resulted from the use of artificials; this seems to be a clear reference to breakdown of structure. The fact that highly sophisticated pesticides and commercial stockfeed preparations are used by these farmers seems to rule out any factor of innate conservatism or supposed ignorance in their failure to take up artificial fertilizers.

A review of the kinds and quantities of fertilizers used is to be found in Chapter XV; here we need merely add a few comments on the role of these materials in crop ecology. Prawn dust is a "complete fertilizer," in the sense that its dry-weight analysis includes about 6 per cent nitrogen, 2 per cent P_2O_5, and 1 per cent K_2O (Milsum and Grist 1941). Thus the only other principal element needed, and used, is lime. Most farms use no other fertilizers, in some cases because of cost in relation to yield increment and in some, perhaps, because of difficulty of storage or application. One problem exists with regard to the use of lime: While some, perhaps all, farmers recognize it to be a fertilizer, some consider its chief value to be as a pesticide; it is believed to kill worms in the soil. Lime may have such a function, unknown to the writer, but it appears more likely that liming, by raising soil pH, or perhaps through its action on structure, reduces root rot which farmers may attribute to worms in the soil, but which probably results from either root asphyxiation or microörganic activity. Farmers also recognize one other result from the use of lime: They remark that it assists in tillage, making the soil easier to turn over; this we attribute to its effect in stabilizing soil structure.

Minor Ecological Elements.-- Four minor, or at least miscellaneous, ecological elements deserve brief mention.

These are: temperature of the soil and lower atmospheric layer; the effect (or lack of effect) of atmospheric turbulence; pests; and the problem of physical support of the plants.

It would appear that the chief problem in maintaining a relatively low daytime soil temperature is that of slowing down the rate of evaporation. The seedlings, at a stage of growth nearing the point where transplanting is to be carried out, appear to provide fairly dense ground cover, and the transplanted crop, after the first few days of recovery from the transplanting trauma, provides almost total ground cover. Thus shade and frequent watering serve to modulate soil temperature. Whether or not temperature has a direct effect on the green parts of the plant, above this shaded zone, cannot be ascertained; in all probability its chief effect is on soil moisture. For young seedlings, however, there appears to be a distinct harmful effect of high soil-surface temperature, which farmers counteract by laying long palm fronds along the beds for the first few days of growth. (We should point out that plant water needs are high at this stage of growth, and it is possible that the palm fronds also serve primarily to conserve soil moisture.)

Wind speed recorded at Kallang airport, some two miles from the farming area, averaged about three miles per hour in 1951; it was probably much less in the plain. The effect of air movement in deepening the evaporation sink over the beds is, of course, important, but inaccessible to the methods used in the present study. Suffice it to say, turbulence was probably unusually low (for an equatorial island) and thus evapotranspiration probably low as well.

Careful observation of pest damage to the vegetables was not carried out. In general, it appeared that leaf damage was remarkably low. This can be understood in terms of (1) farmers' knowledge of pesticides, both imported and local, and (2) farmers' awareness of the desirability of producing a high quality leaf, this being reflected in the careful picking-over of the harvest to remove all leaves showing any considerable damage. The chief pesticides used are an imported DDT preparation and the extract of _Derris elliptica_, both used in solution. The latter is grown locally; the fact that it is losing out in competition with DDT indicates, to the writer, the degree to which farmers in the plain are prepared to accept technological improvements, where these have proven their value.

Finally, the question of mechanical support for the crop plants in the bed is of considerable importance, and has rather striking implications regarding the areal differentiation of leaf-stem vegetable farming in the island. We have already pointed out that the heavy clay soils of the plain have both "good" and "bad" qualities to contribute to the crop ecosystem. One additional "good" quality is to be found in the firm support they provide these crop plants, which are peculiarly liable to laying-over as a consequence, probably, of their heavy tops in proportion to rooting systems. Farmers in the portions of the plain having sandier soils complain of laying-over of the crops after moderately severe rain storms; farmers elsewhere in the plain do not.

It appears that we should add the factor of mechanical support to that of water supply -- permanent ponds and a relatively stable water table -- in examining the reasons why leaf-stem vegetable cultivation tends to be found on heavy, rather than light soils. The importance of mechanical support, and the problem of laying-over of the crop, is probably not so much a function of the anatomy of the varieties, or a function of vegetable-farming in general, but rather of the intense forcing of vegetables which takes place in the plain, the attempt to obtain the greatest possible weight of tops in the shortest possible time. Thus, sandier soils are sometimes considered better for vegetables of this sort in other parts of the world; in the Kallang Plain, however, the combination of economics and ecology leads to a strong preference for heavy clays.

CHAPTER XVIII

ELEMENTS OF ORIENTATION

Economic Values.--In this chapter an attempt will be made to bring into focus the essential elements in what we call the "orientation" of the Kallang farmer toward resources, the elements of value, apperception, and skill. (See Chapter III.) Since little direct investigation of this topic was carried out in the field, our discussion will have to be brief, qualitative, and preliminary.

Clearly, the Kallang farmer's orientation toward resources and resource-using behavior is dominated by what we would consider economically "rational" value-orientations. Materials, including alike harvested vegetables and purchased input factors, are assigned a specific and conscious money value when they involve a money transaction. This holds true, among purchased input factors, for fertilizer, seed, pesticides, stock feed, and tools. The real cost of items which are not purchased, and whose cost must be measured in labor terms -- such as the vegetable beds and hand-applied water -- and the real income derived from consumed crops are also, apparently, well understood. The fact that farmers cannot compute these costs and returns in many cases merely reflects such problems as inability to set a price on farm-family labor, the short-term periodicity of both costs and returns, which makes it difficult for farmers to recollect long-term averages, and the fact that many farmers cannot read and therefore keep no records.

The important consideration here is that leaf-stem vegetable farming in the plain is highly commercialized, and some of the non-economic values governing subsistence and semi-subsistence farming elsewhere simply do not apply. It would be quite impossible for this farming system, or any one like it, to operate under non-commercial or even semi-commercial conditions. For one thing, the high degree of specialization of production implies that the farm family could not shift to a non-commercial, subsistence basis: Man cannot live on vegetables alone. Such a shift could not take place, in addition, because farms are far too small to be able to support a family, regardless of the crops raised, without a high rate of fertilizer input, and this requires large outlays of money, and therefore sale of the crops to pay for fertilizers. And in this regional setting, Kallang farms would be no more than kitchen gardens if production did not yield enough cash income to compete, at least in order of magnitude, with wages realizable in the nearby urban labor market.

Thus the entire mode of functioning of Kallang farms is bound up with commercial production, and farmers, not unexpectedly, are acutely aware of prevailing prices involved both in their costs and returns. In sum, the principal motive underlying nearly all productive decisions has as its source the value-orientation seeking to maximize family real income, which amounts essentially to cash income. From this motive, decisions taken regarding purchases, rates of application of fertilizers, hiring of labor, and time and periodicity of sales can be seen as efforts to reduce costs and increase returns.

It should not be concluded from the foregoing that farming in the plain is explainable in economic terms, except to a fairly limited extent. Given a cash orientation, it is probably predictable that Kallang farmers would select one of a limited number of farming systems, if they selected farming as an occupation at all. Among these systems, the one we should be led to expect most is vegetable cultivation, on the basis of well-known principles of agricultural location -- transport cost and perishability, price fluctuations, and the like. But beyond this point we must call in other factors. For example, were these Chinese farmers less "attached to the land" -- a value concept -- they would almost certainly have foregone farming in favor of urban occupations. Were they less equipped to evolve (or at least adapt) a system which suited both the cultural and environmental conditions of Singapore, they would also have foregone farming (as have the Malays and Indians on the island). This "equipment" includes technological skills and local permissive factors, chief among which is the strongly Chinese character of the colony with its Chinese demand structure and its relatively smooth channels for marketing, land purchase and rental, and acquisition of capital (in the form of credit, sometimes interest-free, on fertilizer purchases).

Furthermore, functional explanations ventured in terms of economic motivation must return to a Chinese value structure of the past which permitted or encouraged motives of this sort, and possibly to a selective factor in emigration which tended to bring overseas those who were most interested in gain.

It is for the preceding reasons that we have relegated our description of the economics of farming, a subject on which large quantities of data were collected in the plain, to a relatively minor place. Costs and returns, for our purposes, are subjective evaluations, not concrete phenomena, and they, as well as measures of profit and scale, will be discussed as derivative orientational elements.

Non-economic Values.--It will be desirable to point out a few instances of motivations based on values which do not reflect the motive of maximizing cash, or even real, income. Our discussion will be necessarily sketchy, since few data on this topic were obtained.

Among Kallang farmers, sex- and age-based division of labor (or lack thereof) is partly ascribable to economic factors, but in some cases is not. For example, we noted that a high value was placed on education of the children, such that a large potential source of labor was foregone to permit children (including older children) to attend school. Farm families contributed cash to the education of the farm children, in addition to losing their labor. Secondly, the physical difficulty involved in having farm women attend to certain arduous tasks certainly played a role in sex-division of labor; insofar as this was not a question of efficiency, the delegation of such tasks to men could be viewed as a value-based pattern. (Some societies, it will be recalled, employ women at the harder tasks of farming, including drawing a plow.) And finally, Kallang farmers definitely subscribed to the not particularly "economic" view that "woman's place is in the home," as is indicated by the division between field and household tasks.

In the matter of apportioning cash returns an important non-economic value element can be discerned. As with most farming groups, excluding perhaps only Euro-American, economically "rational," "farming-is-a-business" groups, Kallang farmers do not bother to distinguish sharply between the production and consumption budgets, or accounts. Keeping no records, and operating an economic unit which involves little land, labor, or capital, they reveal a tendency to treat short-term cash surpluses as a unitary "profit," which may be devoted to increasing stocks of fertilizers, repairing the house, buying desired items of consumption, hiring labor to assist in production, or increasing the family offerings to the ancestors. It is quite impossible to segregate out the economic from the non-economic uses to which such "profits" are put in most cases. But the importance of non-economic values is sufficient to render highly suspect any prediction as to the effect on production of a given increase in family net cash income, i.e., the over-all money surplus. Whether such an increase will be plowed back into production to further increase "profits" in the future is an open question, by no means answered in the present study.

The Apperceived Resource-Using Situation.--In Chapter III we pointed out that the motivations underlying resource-using behavior include, in addition to a basic structure of values, two other elements: apperception of the situation, cultural and physical, in which behavior vis-a-vis resources is to take place, and technical skills (knowledge and neuro-muscular habits) with which to act in the desired manner. Apperception, in turn, includes two elements: first, the perception and recognition of relevant features of the resource-user's total environment, among them habitat materials, instrumental materials, and other individuals; and second, recognition by the resource-user of a meaningful relationship between himself and each of these perceived elements in the environment. It is apperception which is usually the operative variable in productive decisions; values and skills tend to remain fairly constant in the short-run. In order to achieve full functional understanding of a farming system, one must develop a fairly complete picture of the average farmer's apperceived relationship to his environment, since his short-run decisions stem from apperceived "opportunities" and "limitations" in the total environment. Unfortunately, recognition of the importance of this topic came after field work in the present study had been completed; our treatment of the topic is therefore sketchy in the extreme; and we must forego the aim of building a fully comprehensive functional picture of Kallang farming as a result. To do so we should have to know what perceived changes in the total environment "cue" behavior, and what the farmer himself considers the intent and result of that behavior to be. With such knowledge to set against more-or-less objective knowledge of the resource-using situation, we would be able to explain the resultants of behavior, and perhaps obtain useful applications by seeking to lessen the spread between the objective and subjective frames of reference.

The following discussion, then, will serve largely as an illustration of the kinds of data which should be sought under the heading of "farmers' apperception of the resource-using situation." The illustrations chosen are those on which usable data were obtained. It will be noted --- and this is fortunate for the present study --- that the instances where a discrepancy exists between the situation as seen by the farmer and by the supposedly objective observer are rather uncommon.

The effect of rain on soil solids, for example, seems to be quite perfectly understood, at least on the macroscopic, empirical level: It is the beating action of rain, among other things, which destroys soil tilth during a crop cycle; run-off carries away the fine particles and redeposits them on the paths and in the ponds; the mud drawn from the bottom of ponds is, in fact, such material eroded from the beds and other parts of the farm; in fact, mud obtained from the bottom of the Kallang River also started as soil higher up the river or in the farms. One returns the mud to the beds, either directly (in which case difficulties are encountered since such materials are difficult to work) or via the burnt-earth pile.

From the farmers' uniform reaction to artificial fertilizers (at least among those familiar with them), that they "harden the soil," we can infer an empirical awareness of the structure-building properties of organic fertilizers. Burnt earth, also, makes the soil easier to work and more resistant to physical breakdown by water.

Different crops are suited to different soils: choy sam and most leaf-stem vegetables, for example, to the clay soils -- which, for this reason, are preferred -- and spring onion and non-leaf-stem vegetables to sandier soils.

We do not know whether Kallang farmers possess a comprehensive knowledge of the possibilities for developing crop varieties suitable to particular crop-ecological situations. Probably their knowledge is imperfect, but it is definitely not lacking entirely. The idea of selection, for example, is well understood. As an example of this, we might mention one important instance of selection by the farmers themselves. Before World War II the farmers of the plain obtained seeds of choy sam from China or Hong Kong; attempts to grow the crop for seed in the plain had failed. During the Japanese occupation the source of seeds was cut off, and Kallang farmers systematically went about selecting for a variety which would seed under Singapore conditions (presumably day-length conditions). They were successful, and, apparently, nearly all choy sam is grown from farm-produced seed. Since, however, no technical services have been available to the farmers for crop improvement, it is difficult to tell the extent of knowledge regarding crop improvement possibilities. We did not notice any normal procedure for selecting the best plants for seed; in fact, whole beds or portions of beds were set aside for seed production, and it would seem that the only selection which could be made in any case would involve the plants growing fastest in the seedbed prior to transplanting.

Farmers' knowledge regarding the market mechanism seemed to us remarkably complete, although this might be expected in a commercialized situation of this sort where contact with the market comes daily for most farms. Each farmer knew the preceding day's prices, and was able to form a reasonably good prediction of the following day's prices, although not when any change in trend took place (which happened frequently). He could, in addition, predict seasonal changes in the structure of demand, many such changes being tied to the occurrence of periodic Chinese festivals.

With regard to the farmers' belief regarding their ability to influence impinging external conditions of vegetable and fertilizer prices, and also of flooding, there appeared to be unanimity of opinion that no control was possible. Farmers universally felt that factors over which they had no control were in charge of conditions. Wholesalers set the prices; some farmers believed that these, in turn, were ruled by demand and their own costs of distribution, while others felt that they had control of the situation themselves. At the time of our field work a large quantity of vegetables was entering Singapore markets from farms in Johore, newly opened-up as a result of squatter resettlement (cf. Dobby 1954); Kallang farmers were well aware of the impact of the increased supplies on market prices, which were declining rapidly during the late months of 1952. As to flooding, which some form of regional water-control would have, in all probability, ameliorated, farmers appeared to be, on the whole, rather fatalistic: Individually they could not provide such control, and they seemed to have no hope of outside assistance.

Technological Knowledge.--One of the essential orientational elements is, of course, the farmer's ability to handle materials potentially or actually available to him in the resource-using situation. This implies a knowledge of tools and their uses, of methods of altering crop ecology, of the crops themselves, etc. At various points in the preceding chapters we have dealt with aspects of this question, so no data need be presented here. Suffice it to say, Kallang farmers' technological knowledge appears to be rather complete for the farming system practiced, the only important exceptions being in the area of knowledge concerning crop improvement and chemical additives, and in the area of regional, i.e., external, control of impinging factors such as water and prices. No better tools or crop practices seem capable of improving farming in the area, apart from the exceptions noted.

CHAPTER XIX

FARM ECONOMICS

Farm Receipts.--In the present chapter we shall attempt to use the cash value of production and input items as a means of expressing two aspects of Kallang farming: the almost universal measure used by farmers of this region for placing comparative economic values on input and output elements in resource-use, their money value; and the *intensity* of process elements in production, which, in some cases, is best expressed in money terms.

The term *farm receipts* as used here refers to all cash and credit receipts (or returns) obtained from the sale of farm produce of all types. Included, therefore, are receipts from vegetable, livestock, and tree-crop enterprises. Specifically excluded are earnings from non-farm employment, since these provide no indication of the scale or success of the farm itself. Home-consumed farm produce, and produce fed to stock, are also excluded, although the value of these items will figure in later analysis. (This usage is a simplification of the conventional definition of farm receipts, since it does not include an item for change in farm capital.)

Calculation of farm receipts is based on a single average growers' price for each separate product, derived from the best available price data. Prices covering identical periods for all farm produce were not obtainable. For vegetables (the only important receipt items) and tree crops, in the absence of 1951 prices, and with no data on monthly sales quantities, an unweighted average of mean monthly prices for the first half of 1952 has been used in each case. These prices are mutually comparable, but are probably somewhat higher than the average for the entire survey year. This, however, compensates for a probable bias in favour of early 1952 yield and fertilizer rates and will, in any case, be taken into account in subsequent analysis. The prices used for pig and egg sales are, in the absence of 1952 figures, 1951 annual means. Poultry prices are an unweighted average of 1951 and 1952 annual means. Lack of strict comparability as between livestock and crop prices--resulting in part from lack of monthly figures for the former--does not significantly affect total receipts in view of the predominant importance of ground crops. (Growers' prices at market are used in all cases.) Vegetable, tree-crop, and poultry prices have been obtained through the courtesy of the Department of Agriculture, Singapore; pig and egg prices are drawn from the 1950-51 Annual Report of the Veterinary Department (Singapore Veterinary Department 1952). All figures are in Malayan dollars (equaling about U.S.$.33).

Total farm receipts for all farms are estimated to be $962,600 for the year, or a mean of $5,660 per farm; 91.8 per cent of the total are vegetable-crop receipts, 7.9 per cent are livestock and livestock product receipts, and the remaining 0.2 per cent are tree-crop receipts.

Vegetable-crop receipts total approximately $883,930, of which over 99 per cent are from leaf-stem vegetables. For the 169 farms growing leaf-stem vegetables, the mean annual receipts from vegetables are about $5,260. The mean value of crop sales per square foot of cultivated land is approximately $.88. Choy sam receipts, estimated at $492,290, account for about 55.7 per cent of the total. Estimated total receipts for the remaining important crops, excluding sai yung choy and kai choy,[1] are as follows: kai lan, $83,240 (9.4 per cent); choong, $52,060 (5.9 per cent); kan choy, $47,350 (5.4 per cent); pak choy, $44,630 (5.0 per cent). Other crops amount to $164,360 together, or 18.6 per cent of the total.

Livestock and livestock product receipts total approximately $76,440, broken down as follows: pigs, $67,960; hen eggs, $5,100; chickens, $2,640; ducks, $750. Thus, pigs, with 88 per cent of the total, predominate, although poultry, which contributes an important part of the value of home-consumed items, is more significant in farm economy than is shown in these figures. For the forty farms with pigs, the mean sales value is approximately $1,700. Tree crops, with total sales

[1]Usable prices have been unobtainable for these two crops. In the estimation of total crop receipts and expenses, the area in these crops has been converted to choy sam as an analytic procedure, and calculations are based on the latter crop. The rationale for this procedure is based on the similarity in annual value per square foot for the major crops and is supported by theoretical considerations.

of, very roughly, $2,230, are of no importance in the area. (The calculated total sales value of tree crops is highly inaccurate, since, on the one hand, average rather than reported yields have been used and, on the other, prices are available for only coconut, jack fruit, rambutan, and lime, among the significant species. However, no errors can have bearing on the total picture in view of the unimportance of this enterprise.)

Farm Expenses.--The term farm expenses refers to all significant money expenses involved in the normal operation of a farm, and includes expenses incurred in production, in marketing, and in farm upkeep. (Certain minor non-cash expenses, normally considered under the term, are excluded.) A comparison of farm receipts and farm expenses provides a summary picture of a farm's money economy, but not a complete one, since farm expenses include costs involved in non-receipt (unsold) production, and exclude the non-monetary cost of family labour.

Total farm expenses for the 170 farms amount to an estimated $687,050 for the year. The mean per farm is about $4,050, or $1,610 less than farm receipts. This difference of $1,610 may be treated as the average amount of money available to a farm for application to the family budget, for increasing farm capital, for example. A breakdown of farm expenses into component items shows fertilizers to be the predominant item of expense, accounting for 71 per cent of over-all farm expenses, 83 per cent of production expenses, and 93 per cent of vegetable production expenses. Production expenses include in addition to fertilizer, stock feed, pesticides, and seed and other planting material as significant items. All of the foregoing, with the exception only of stock feed, and the addition of hired labor expenses are involved in the vegetable production enterprises. (The cost of durables such as tools is considered an upkeep expense here for convenience.) Other expense items, in descending order of importance, include stock feed with 9 per cent of over-all expenses; marketing with 8 per cent; repairs and replacements in tools, farm structures, and the like, with 5 per cent; pesticides with 3 per cent; seed and other planting material with 2 per cent; rent with 1 per cent; and hired labor with 1 per cent.

The total expenditure for fertilizers amounts to an estimated $480,330 for the year, or a mean of $2,860 for the 168 farms with ground crops. Approximately $467,140, or 97 per cent of this total, were spent on prawn dust, $9,380 or 2 per cent on lime, and the remainder on sharks' fin, fish waste, oil-seed cakes, and other minor fertilizers. (Fertilizer expense figures have been obtained by multiplying quantities by the stated average prices for the survey year.) Minor expenses in vegetable production include an estimated $21,080 for pesticides and $12,790 (adjusted) for seed and other planting material, or means of $120 and $80, respectively, per farm with ground crops. (The figure given for seed expenses is based on total value of seed, rather than purchase value. This adjustment for farm-produced seed is made to compensate for the area set aside for seed production, and therefore producing no saleable crop. Actual seed purchases total $7,780 in value.)

Stock feed is the only significant direct expense in livestock production found on Lower Kallang Plain farms. The total value of feed is estimated to be $60,820, or a mean of $660 for the 92 farms reporting stock. The total value of pig feed is estimated to be $44,650 (or a mean feed bill of $70 per pig raised for sale); of poultry feed, $16,170.

Money expenses involved in the repair and replacement of farm structures, tools, and similar items, most of which are material costs since labor seems usually to be farm-supplied, total about $35,700 (the figure is an extrapolation based on direct reports from 107 farms), for the 170 farms in the area, or a mean of $210 per farm for the year. Adjusted marketing expenses total $55,540, or a mean of $330 per farm with ground crops. Actual marketing expenses are incurred only by farms sending produce to city markets by lorry, at a median charge of $1 per day regardless of quantity transported. Farms selling produce at the farm obtain a considerably lower price, too variable to allow calculations to be based on it. To compensate for this price deficit, all farms are charged with a marketing expense and city prices are used.

An accurate estimate of rents cannot be given. Of the 63 farms providing answers to questions on tenure, 30 hold government Temporary Occupation Licenses, and 33 paid rent to private individuals who in some cases hold Temporary Occupation Licenses and rent to sub-tenants. For the holders of

Temporary Occupation Licenses, the mean annual rent is $22; for sub-tenants, the mean rent is $80. Assuming the same proportions of private Temporary Occupation License tenure relations, and the same mean rents for each, for the entire area total annual rent expenditure for the 170 farms is estimated to be $8,830, or a mean of $50 per farm. (This assumption can be made here since if all remaining farms are privately rented, the total expenditure will be only 1.8 per cent of total farm expenses. The amount involved is therefore insignificant, and the range cannot influence further calculations based on farm expenses.)

Hired labor, estimated to total about 820 man-days for all farms for the year, and paid a wage averaging $7.25 (or $5.30 plus meals, amounting to the same sum), cost farms in the area$5,980.

Value of Farm Privileges.--The foregoing deals exclusively with money receipts and expenses--or, as they are usually termed, "cash" receipts and expenses. To obtain a complete picture of real income it is necessary to add non-cash items, termed "farm privileges." Since these provide 6 per cent of total returns--cash and non-cash receipts--they are of significance.

The total value of farm privileges is estimated to be $58,920, or a mean of $350 per farm. Out of this total, the value of farm produce which is consumed at home, reckoned at growers' price in each case, amounts to an estimated $48,630, or a mean of $290 per farm. Crops provide $37,720, poultry $8,240, and tree crops (very roughly) $2,610. The only other significant item is the computed rental value of the farm house. This is clearly a farm privilege, since budgets for non-farm families include rent as a cost item. The total rental value of all farm houses is estimated to be $10,350, or a mean of $60 per farm. (Rental value is calculated on the basis of square footage. A figure of $.06 per square foot per year, kindly supplied by the Department of Agriculture, is used.)

Economic Summary Measures.--As we have seen, mean total money (or cash) expenses per farm amount to about $4,050 and mean total money receipts amount to about $5,660, for the year. If non-cash items, the value of farm privileges, are added, the mean total returns per farm amount to about $6,010.

In the following discussion farm expenses are limited to money items, excluding certain non-cash items normally included. Farm capital is assumed to have remained the same for the area as a whole throughout the year: As usually considered, changes in farm capital are analytically significant only for individual farms, and average changes for a region are usually small for any one year. No charge is made for interest on farm capital--a non-cash cost item adjusting for the return which would have been obtained if farm capital had been invested elsewhere. Accurate calculation of interest is impossible on these farms; the value of farm capital is low (land is not owned, equipment is simple, inventories are low, and houses are relatively inexpensive), has accumulated in gradual, small increments, has never been assessed, and is unknown to the farmer; and interest rates cannot be determined with accuracy. If (as seems likely) farm value averages below $2,000, an interest charge would not increase total costs much more than 3 per cent, and probably considerably less. A second non-cash cost, that of unpaid family labor, is also excluded. The purpose of calculating this item is normally to separate the final returns for management from all other returns -- for family labor, capital, land. In this context, however, family labor cannot be separated from operator's labor, and, in any case, does not function in the "usual" -- i.e., Euro-American-- manner.

The difference between money expenses and money receipts, averaging $1,610 per farm, is termed <u>family net cash income</u>. (This measure varies slightly from the usual usage, since changes in farm value are excluded.) This represents the <u>money</u> profit, available for all family cash expenses, for a year's operations. It is an important measure of economic success in this area, where farming is highly commercialized, and where the type of farming depends to such a large extent on purchased material input factors that a shift to semi-subsistence production is out of the question. Apart from vegetables, poultry, and house rental, all items in the family budget must come out of cash income.

To put the income of lower Kallang farms on a basis comparable with both urban family income and family income on farms elsewhere in the Colony, it is necessary to add the value of farm privileges to farm receipts before subtracting costs. Since the mean value of farm privileges is $350 for the area, mean total returns are thus $6,010, and the difference between this value and farm costs amounts to about $1,960. This figure, the mean family labor earnings for all farms for the year, is the best available measure of economic success for farms as a whole since it represents the average total profit, including both cash and non-cash items. For comparisons between farms, however, it is not as useful as a derivative measure which takes into account variations in the number of workers on farms or, to be more precise, the number of man-years of labor contributed. This measure, termed labor earnings per man (or man-year), is obtained by dividing the mean family labor earnings by the mean number of man-years of actual labor put into the farm during the year (the "man equivalent," in farm management terminology). Labor earnings per man average $770 for all farms.

Part V: Synthesis and Conclusions

CHAPTER XX

FUNCTIONAL MODELS, LOWER KALLANG PLAIN

The Synthesis of Process Elements.--This portion of the study will consist of an attempt to draw together the separate strands of process, material, behavioral, and orientational, into a coherent picture of the functional field which characterizes Kallang leaf-stem vegetable farming. We are building a composite picture of the average farm, viewed functionally, and are thus synthesizing (actually re-synthesizing) the individual process elements previously abstracted and described separately. This synthetic picture can be termed a "functional model" of the field: Its qualitative attributes, or patterns, consist of the individual process elements and their modes of interaction; its quantitative attributes consist of the intensity of process activity and process transactions,[1] measured on an economic scale.

Three aspects of the field are fundamental. First, we must know the kind of process activities and transactions which are involved. Second, we must know their intensity.

[1] We shall use the term "process activity" in this chapter to indicate the functioning of a given, arbitrarily differentiated, process, such as a labor task. The term "process transaction" will designate effects of any one such arbitrarily differentiated process on any other. This distinction is purely one of immediate convenience.

And third, we must have a summary picture of the intensity of resource-use for the field as a whole, what some call the "scale of farming." From the discussion in preceding chapters, it will be clear that we should have little difficulty with the first aspect: A qualitative picture of the major process activities and certain transactions has already been presented. As to the second, our data are rather spotty: In some cases we have strong quantitative information, in others weak quantitative information, and in others little or none. The third, synthetic, aspect is no stronger than the second, since it builds on it.

For our present purposes the high degree of commercialization in Kallang farming is fortunate. It allows us to use price value as a common measure of process intensity for nearly all productive processes in the plain, excluding only the decision-making processes of orientation. (In a conventional farm-management study these processes could be "priced" under the heading of "returns to management." Here, unfortunately, it has proven impossible to separate "management" from "labor.") It is important to realize that the assigning of price- or money-value to an item is merely to recognize its degree of "valuableness" to the farmer and others within the supply-production-consumption network. Our scale of intensity is, therefore, a measure of orientation, of the situation as subjectively apperceived, rather than a measure of any inherent physical degree-of-intensity within the processes themselves. To obtain the latter we should have to return to some ultimate common denominator such as mass-and-energy, or be satisfied with different scales for different sorts of process -- e.g., weight for production, or man-hours for labor. The fact that Kallang farms are almost totally commercialized means, then, that physical immiscibles are arrayed along a common value continuum. Were this not the case we should be unable to insert quantitative coefficients for each term in the functional equation, or would have to erect separate models for each aspect of the field which required measurement on a different scale -- possibly man-hours for behavior, weight for materials, for example. It seems highly probable to the writer that models of the sort presented here, having only a single scale of intensity, apply only to two essentially polar situations: almost complete commercialization, where price can be our scale, and almost total non-commercialization, where labor or possibly caloric intake might be our scales. Elsewhere, unless cash items can be converted to labor units, or vice versa, a quantitatively "tidy" model might not be attainable.

On the other hand, the degree of applicability of a price scale varies from place to place within the model. Labor, for example, might be valued on the basis of possible alternative wages, using urban employment as the indicator. (In this case all farms would be losing money.) Our selection of family labor earnings as the means of determining labor value is thus a rather arbitrary one. Again, orientational processes can be assigned no price. And elsewhere the utility of the scale varies with the quality of our data. The writer entertains a strong suspicion that our use of family labor earnings as a means of arriving at labor value undervalues those aspects of the system which depend on labor rather than purchased materials -- e.g., watering and tillage -- since family labor earnings represent a residual after all expenses have been subtracted from receipts, and comes out rather low in terms of returns to labor and therefore value of labor-derived process elements.

Internal Process Elements.--The field itself encompasses processes which are assumed to have their loci within the spatio-temporal limits of the farm; these internal, or emergent, processes make up the content of the field. The classes of process involved are outlined below, with references to the place or places in the preceding pages where each is taken up separately. (This is, of course, only one of many possible typologies.)

I. Material elements. (Chapters IX, XII, XIV, XV, XVI, and XVII.)
  A. The derived micro-environment.
    1. Subsoil character: physical and chemical nature; moisture and air relations; organisms.
    2. Bed soil character: physical and chemical nature; moisture and air relations; organisms (other than crop plants).
    3. The climate near the ground.
    4. Bodies of standing water: ponds, drains, the river.
    5. Weeds.
  B. Crops and stock.
    6. Bed crops.
    7. Other ground crops (e.g., kang kong and water cress).
    8. Tree crops.
    9. Livestock.
  C. Productive material culture.
    10. Tools and equipment.
    11. Structures.

12. Crop and stock nutrient increments (lime, fertilizers, seed, and feed) and pesticides.

II. Behavioral elements. (Chapters XIII, XVI, and XVII.)

13. Building beds and maintaining ponds, drains, and paths.
14. Tilling.
15. Fertilizing.
16. Watering.
17. Planting and transplanting.
18. Weeding.
19. Harvesting and associated tasks.
20. Marketing and supply tasks.
21. Minor tasks in crop production (e.g., preparing and applying burnt earth and spraying insecticides).
22. Animal husbandry tasks.

III. Orientational elements.

23. "Economic," i.e., productive, values.
24. Relevant non-"Economic" values.
25. Technological knowledge.
26. Apperception -- including a subjective understanding of all material and behavioral classes listed above, as well as impinging external process classes.

Impinging External Processes and Boundary Transactions.-- The field functions in a space-time matrix whose extent would appear to be infinite. Practically, however, we can discern a set of what might be termed "secondary" or "second-tier" processes, those bearing directly on the field though external to it. It is extremely difficult to set up a typology here as was done with internal process elements; our discussion will, therefore, have to be somewhat incomplete.

Certain transactions across the field boundary are obvious and measurable. One such class of transactions might be termed "environmental" -- rainfall, insolation, air movement, regional ground-water movement, and the like. Another involves also the movement of materials across the boundary, but with a human agent involved more or less directly.

Included here would be sale of crops and stock, purchase of materials, the obtaining of water from the river or regional drains, and the like. In this group both behavioral and material processes are involved.

A third, highly complex and not easily measured, group of boundary transactions are those crossing the interface between productive and non-productive orientations. For example, the decision to carry out a certain task at a certain time involves the rejection of alternate, non-productive activities for that time period; or, the decision not to engage in productive activities during a Chinese festival involves a rejection of productive activities in favor of non-productive ones. Unfortunately, our inquiry by-passed this critical problem entirely.

The boundaries of the field in these cases are clearly orientational or psychological. Another sort of orientational transaction involving external elements is tied in with apperception. Motivation toward productive behavior involves, among other things, a recognition of external factors which relate to the consequences of such behavior. Among these apperceived elements we may mention, almost at random, the following: prices; the urban labor market; weather indications; family health; debt; the presence or (more commonly) absence of governmental assistance; the farmer's attitudes vis-a-vis individuals with whom boundary transactions take place, the status of these other individuals, and favorable or unfavorable aspects of the relationship between them and the farmer. Here, again, our analysis produced few useful data, although some exceptions are discussed in Chapter XVIII.

Qualitative Functional Models: Crop Cycle and Day.--The activities of, and transactions among, processes can be woven into any of several different functional models. Unfortunately, functional models cannot be abstracted from the spatio-temporal setting: We cannot construct a static, moment-of-time picture such as can be done with a spatial structural model, nor can we place the process elements in a simple chronological sequence. Both spatial and temporal coordinates must be incorporated into the model. Recognizing the semantic limitations on describing such models in words, we shall attempt nevertheless to construct one.

In Chapter III it was pointed out that temporal limits of a functional field are much more vague than are spatial limits: We can define the diachronic, functional time-span as a year, or the period of field work, or a decade, while the compelling spatial limits, at least in a subject such as the one we are dealing with here, are the boundaries of the farm (extended, of course, to the market and supply shop, and including only productive processes within the spatial limits of the farm). In view of the fact that our data for periods of time even as short as one year are far less accurate than those for even shorter periods, it seems desirable to select the shortest possible time unit which has some recognizable integrity for our field boundaries. Two such are reasonable candidates: the <u>modal crop cycle</u> and the <u>day</u>. The day has the disadvantage that, although there is a recognizable cycle of material, behavioral, and orientational processes within the period, it is too short to encompass processes whose "wave length" is that of the crop cycle or bed cycle. The crop cycle, on the other hand, obviously obscures daily cycles. A combination of both seems preferable.

Accordingly, we shall deal with a period defined as the modal crop cycle of forty-one days, and assume a farm on which all daily cycles are identical, e.g., as much as marketed on each day as on all others. We shall further assume that only one crop is grown on the farm. The overwhelming dominance of choy sam, and the fact that this crop conforms to the norm in most phases of crop management, allows us to use choy sam as the selected crop, rather than some unreal composite abstraction.

The area of the farm is that of the average farm in the plain, one-half acre. The number of people dwelling on it is modal, as is the division by sex, age, and status in the labor force: The farm has two adult males, one of whom is employed elsewhere throughout the period, the other being "the farmer;" it has two adult females, neither of whom is employed elsewhere; and it has three children. To simplify the picture we shall allow the vegetable beds to be larger than the average in the plain, so that operations such as bed-preparation, harvesting, etc., which, on the average farm in the plain, are repeated one and one-third times each day are repeated only once daily in the model. Prices will be assumed to remain stable (although the farmer cannot be expected to know this from day to day), and all other fluctuations in impinging conditions will also be assumed to remain stable, while occasional events such as flooding and festivals will be left out of the model.

Because we are limited as to the amount of detail we can fill in for our model, and because, too, the model is essentially illustrative, we shall focus on two space-time segments, one temporally deep and spatially narrow, the other temporally narrow and spatially broad. These are: a single bed throughout the crop cycle, i.e., throughout the time-depth of the field; and the farm as a whole for a single day. To cover all changes taking place in vegetable beds, we will assume, in the case of the crop-cycle segment, that the bed contains transplanted vegetables during the first twenty-one days, then is worked up as a seedbed and contains seedlings during the remaining twenty days. (If we began with a newly prepared seedbed, we would have to leave out pre-transplanting and transplanting processes, since the seedbed retains a portion of the original crop after the remainder has been removed to other beds.)

The decision to work up and replant a newly harvested bed is a routine one: Under the normal conditions we are assuming, the farmer desires to keep the bed producing continuously. Accordingly, on the morning following harvest, the operations of bed-fitting and concomitant changes in the physical and chemical character of the bed take place. The soil has become somewhat compacted, has been depleted of much of its nutrient supply, and has lost a certain amount of clay and silt to the adjoining paths. The farmer, using a hoe, works through the soil in the bed, opening it and building large clods to a depth slightly below the rooting zone of the coming crop (seedlings). Some hours later, when evening is approaching, he applies prawn dust, with the assistance of one of the farm women, waters with the shoulder-borne apparatus, and transplants the seedlings. After these operations the soil has been brought up to very near the ecological optimum in moisture and structure, with sufficient pore space to sustain aeration, and the fertilizer newly added to the soil, is, in a sense, ready to become available as the plant recommences normal physiological processes slowed or stopped during the transplanting "trauma."

During the next three weeks soil conditions in the bed fluctuate as regards moisture, aeration, and fertility. The amplitude diminishes for moisture as plants grow closer together and create a more uniform microclimate beneath the leaves. Fertility may remain moderately stable, since the prawn dust breaks down slowly. During this period daily watering is the rule, with the number of waterings varying between one (occasionally none) and three. Weeding is probably unimportant, since the crop is now able to compete with most weeds. Decisions regarding productive activities are limited largely to such things as determining when watering should take place during each day, the choice being based on perception of weather and soil conditions. Both the decision and the task are carried out by the farmer himself, using the shoulder-borne apparatus.

A critical decision must be made during the few days when the crop is at optimum saleability -- large enough to provide a good yield, though not so old as to be below the optimum in quality. Based on a prediction regarding prices, the farmer must decide which day is to be the one for harvesting. On the appointed day, late in the afternoon, the entire family assembles around the bed and harvests it as a whole. One of the farm women carries the crop to a pond, washes it and arranges it, wet, in baskets. The following morning at 3:00 one of the women carries it to the nearby track, meets the market truck, and accompanies it to town. At Hong Kong street she sells it, then returns with the truck.

The soil in the bed has again declined well below the optimum in physical and chemical composition. Since the following crop is to be grown from seed, the repetition of bed-preparing tasks is carried out with much greater care, especially as regards the fineness of tilth. The bed is hoed and rebuilt (in the morning), then limed, fertilized, and worked over again with a rake (in the afternoon). Each of these operations except liming and fertilizing is undertaken by the farmer himself; one of the women does or helps with the remainder, and also carries out the watering (before or after seeding) with the hand pump. Seeds are planted, palm fronds are laid over the bed, and the new ecological situation thus created is similar to that following transplanting, except that the soil has a finer structure and has a higher pH. If burnt earth has been added, it is even closer to the optimum in aeration. We might note that the decisions taken to carry out each of the preceding tasks are routine, and can be derived from the basic decision to keep the bed in production and achieve the highest possible rate of growth and the lowest rate of loss of seedlings.

Subsequent operations on the seedbed are qualitatively similar to those for the maturing bed, and soil changes are similar as well; the quantities of fertilizer and water applied, the amount of weeding, and other such operations differ, however.

Finally, about twenty days after planting, most of the seedlings are removed (by both the farmer and one or both women at midafternoon) and the bed itself returns to the condition it was in forty-one days earlier.

The foregoing description will be seen to be essentially a composite of earlier descriptions of behavior, ecology, and other factors, the principal exception being that alternatives in decision-making, behavior, and ecological conditions are not considered: We are dealing with a simplified, ideal, model. In the following synthesis of processes taking place during a single day, the compositeness and simplification are retained. We shall simplify further by assuming modal climate and soil conditions for the day: no rain, moderate cloud during parts of the day, and the soil not seriously below field capacity at dawn.

One of the farm women is marketing the previous evening's harvest from 3:00 to perhaps 7:00 AM. Between 6:00 and 7:00 the farmer and the remaining members of the family arise. The farmer spends a few minutes at the nearby coffee shop before beginning work. During this time the plain is shrouded in mist, and little sunlight penetrates.

The farmer's first task is to begin preparing the bed harvested the previous evening. This set of operations occupies him from 7:00 to 8:30. He hoes the bed, returns to it the soil washed down to the paths, and applies burnt earth. The remaining beds are in varying conditions of tilth, fertility, and aeration, since crops at all stages of growth occupy them. However, soil moisture during the period is too high to require any replenishment by hand-watering, except, perhaps, on beds carrying newly sprouted seeds. At this time of day none of the women is in the field.

At about 8:30 the farmer notices that the soil has dried sufficiently to justify the first watering. He leaves the bed-preparation tasks and carries out the watering, a task which takes him about one and one-half hours. At 10:00 or thereabouts he returns to the bed-preparation tasks, continuing thus until 11:00, when a second watering is carried out. Between 10:00 and 11:00 one of the women comes into the field, waters the newest seedbeds, and does some weeding.

As insolation increases, transpiration and evaporation are increasing and soil moisture is dropping. During the first watering, soil moisture increases again, then declines until the second watering. There is a corresponding change in the growth rate as these fluctuations occur.

Lunch is taken at 12:00, at which time bed-preparation and the second watering are both finished. At 1:30 the farmer returns to the field. His first task is to provide the third watering, considerably heavier than the first two, and completed about 3:30. (We assume, again, a decision to water based on the condition of the soil, and a decision as to the amount to be applied to each bed based on growth stage, the appearance of the soil, and the weather indications.) This is the time of maximum growth, assuming continued sunlight, thus maximum water use, and thus heavy watering.

At about 2:00 one of the women comes into the field, weeds, and waters the new beds. At 3:00 the second woman joins her, and both begin the operations associated with planting and transplanting: fertilizing, watering (with the hand pump), putting in the seed, and removing and replanting the seedlings. The farmer himself joins in these tasks of preparing seedbeds, seeding, and transplanting. While he is thus engaged the women begin harvesting, joined, at about 4:00, by the older children. At 5:00 the farmer also begins to assist with the harvesting. At 6:00, as the task nears completion, the second adult male (let us call him the farmer's son) returns to the farm and helps with the harvest. At 6:00 the farmer turns, for a short while, to other field tasks -- fertilizing in particular, but also a small amount of weeding and other operations. By 7:00 the washing and bunching of the harvested crop is completed and the family leaves the field.

The model of process transactions within the field during a single day is rather arid, for at least two reasons: first, because major growth changes do not occur in a single day; second, because those tasks recurring each day tend to provide a rather uniform pattern, governed by simple decisions which are derived from longer-term decisions regarding production rates, and like factors. We need not comment on the apparent similarity between this description and the daily cycle of behavior described in Chapter XVI, beyond emphasizing that a temporal slice as thin as this fails to reveal the dynamism of all phases of the process field except behavior.

It is desirable, at least in theory, to build a model at a considerably higher level of abstraction, where process activity and transactions are withdrawn from particular space-time contexts, i.e., actual positions in temporal sequences and spatial zones. At this level we can speak of distinct kinds of relationships, for example, the effect of hoeing on soil pseudo-structure, the effect on soil fertility and structure of microörganic breakdown of prawn dust into mucelages and other products of decay, the chain of orientational processes intervening between the farmer's becoming aware of a price increase and his translating this perception into motives for action, and the like. Unfortunately, our data are not exact enough to build a model on the basis of such relationships. As regards them we can merely refer the reader to Chapters II, III, and IV, where the meaning of the relationships is discussed.

A model at the level immediately below the previous one can, in theory, be constructed, and might prove useful. In such a model we would attempt to trace the multifarious connections among the three process classes, orientational, behavioral, and material. Each element of value would be traced through the effects it has on apperception, then, indirectly, on behavior, and finally, even more indirectly, on changes in materials. Each task would be assigned a complex of values, apperception, and skills which engender it, via the decision to carry it out, and each such task would be traced in the other direction through a set of effects on crop ecology and other facets of farming. Again, our data are far too inadequate to attempt such a model, which would, in any case, never approach completeness in the present state of our knowledge of psychology. It may be well, however, to illustrate part of such a model in a highly simplified form, using one distinct task, watering, as our center of focus:

Orientation

NON-ECONOMIC VALUES: "A man's task"

ECONOMIC VALUES: "Maintain maximum production"

APPERCEPTION: Dry condition of soil surface

TECHNICAL KNOWLEDGE: Method of using the dual-bucket apparatus

D E C I S I O N

(rejected)

(elected)

(rejected)

Behavior

COMPETING NON-PRODUCTIVE TASK: resting

WATERING by the farmer, using the dual-bucket apparatus

COMPETING PRODUCTIVE TASK: tilling

Materials

PLANT LEAVES: become wetted and cooled; slower transpiration

SURFACE CLIMATE: decreased evaporation; lower humidity; lower temperature

PLANT ROOTS: increased water intake

SOIL: higher moisture content; slightly lower air content; slight loss of structure

This diagram merely suggests the general pattern of process transactions which are involved.

Another way of illustrating process transactions within the field is to treat behavioral processes as the dependent variables and enumerating the material processes which most directly relate to each such behavioral process. Clearly, in a functioning system of this sort, each process affects every other one, but certain fairly distinct clusterings emerge. In the following tabulation, behavioral processes are listed individually and, for each, the material processes most directly related are listed, these latter being divided into "non-purchase" materials, what might be considered from some points of view non-cost materials (if we exclude rent), such as land, crops, and weeds, and "purchase" materials, those which are bought or could be bought if farmers chose not to produce them (at a cost in labor) themselves.

Behavioral Task	Non-Purchase Materials	Purchase Materials
Building beds, maintaining ponds, paths, etc.	Soil physical properties Weeds;burnt earth	Hoe and other tools
Tilling of beds	Soil physical properties Burnt earth,weeds	Lime
Fertilizing	Soil chemical properties Soil physical properties Crops, weeds; microclimate	Prawn dust Lime Tools Storage room in house

Watering	Soil physical properties Soil chemical properties Ponds & drains Crops & weeds; burnt earth Paths (between beds & pond); microclimate	Dual-bucket apparatus Hand pump Pail
Planting & transplanting	Soil physical properties Soil chemical properties Palm fronds Microclimate Crop(seedlings)	Seed
Weeding	Weeds Crop Soil chemical properties	None
Harvesting	Crop Pond	Baskets
Marketing & supply	Crop	Fertilizers Seed
Mixing and spraying pesticide	Crop Soil physical character	Pesticide Hand pump Pail
Applying and making burnt earth	Soil physical character Weeds	None
Preparing stock feed and feeding stock	(Crop--if fodder)	Stock feed Boiling vat
Collecting seed	Crop	None

<u>The Quantitative Functional Model.</u>--One of the principal difficulties we encounter in our model-building endeavor has as its root the fact that field work for the study was not designed with this form of synthesis in mind. As a

result, much information which would be applicable to the synthesizing and model-building process was left out in favor of other sorts of data which have since proven considerably less important. We emphasize this shortcoming here to explain why quantitative models consisting simply of the first two qualitative ones presented in the preceding pages (the day and the crop cycle), with numerical coefficients added, cannot be constructed. We simply did not obtain the necessary data on such things as exact time input in each task, periodicity of fertilizing at various stages in the crop cycle and the amount applied each time. (Actually, rather strenuous attempts were made to obtain such data, but the felt need to obtain other sorts of data held the amount of effort devoted to these below the threshold of adequacy for the present purpose.) Thus our approach to a quantitative model will have to be somewhat different, and much more highly generalized.

Bearing in mind the qualification discussed above, that process elements whose cost is largely a function of labor input appear to be undervalued, it is nevertheless possible to assign a cost, or price, value to each productive process cluster. Each such cluster consists of a constellation of behavioral and material processes (with, we assume, orientational processes attached) or of material processes alone. The value is an average annual one derived from three kinds of cost: direct cash expenses; expenses for non-purchased items which are supplied by the farm itself;

and costs calculated solely from labor input. The last-named are calculated in two stages: First, mean family labor earnings are determined; and second, the labor input for each group of tasks is determined as a percentage of total productive time input, and therefore of the total value of labor, which is the same as family labor earnings.[2] The limited number of observations in the activity analysis means that all figures on time-input are subject to considerable error.

Since we know the critical quantities for estimating the value of labor (family labor earnings, and approximate per cent time-input devoted to each group of operations), it is possible to pro-rate labor costs among the various cost elements of production (or productive process clusters) and obtain figures for the real cost of each such element. It will be noted that money cost plus labor cost together give a total cost figure equal to total returns; in other words, total returns less returns to labor equal money costs. (We include under money costs here those capital items which might be purchased but are produced on the farm.) Thus it no longer matters whether we use total costs or total returns as our indicator of the over-all scale, or intensity, of farming: Both have the same value.

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[2]The labor earnings from marketing have been calculated in a different way. The difference between prices realizable by sale in the market and by sale on the farm is assumed to be a kind of "value added by marketing," and is considered to equal labor earnings from marketing. This sum, averaging $330 per year, is not included in family labor earnings.

The next step is to assign money values to each of the productive processes or groups of processes. Again, however, the problem of converting "woman-hours" and "child-hours" into man-hours arises, since we must divide the total family labor earnings ($1,960) among the productive tasks in proportion to the value of labor performed on each task. To do this, we shall calculate "woman-hours" to be equal to man-hours in weeding, harvesting, and fertilizing; to equal 0.75 man-hours per hour in watering, on the assumption that half the watering undertaken by women employs the light hand pump, in the use of which they are apparently as efficient as men, and the remainder the heavy shoulder-borne apparatus, in the use of which they may be half as efficient as men; to equal 0.50 man-hours per hour in tilling, a heavy task; to equal 0.75 man-hours per hour in planting and transplanting, in which some tasks are performed as efficiently as by men, and others perhaps half as efficiently; and to equal the same ratio for the remaining miscellany of productive tasks. (Marketing is excluded.) The total effect of altering "woman-hours" and "child-hours" (0.08 man-hours per hour) to man-hours is to reduce the total number of unweighted hours of labor per year by 21 per cent. No task had its labor input reduced in this weighting process by more than 28 per cent.

On the basis of the foregoing calculations, annual labor costs, or labor value, for each group of tasks are roughly as follows: watering, $210; weeding, $270; tilling, $500; planting and transplanting, $250; harvesting, $440; fertilizing

$120; preparing stock feed and feeding, $80; mixing and spraying pesticides, $50; collecting seed from mature crops, $20; preparing and applying burnt earth, $10; miscellaneous, $10.[3] Marketing labor is valued at $330, after lorry tolls are subtracted.

Each of the classes of productive behavior functions in relation to several material processes -- e.g., watering relates to soil, ponds, crops, weeds, and tools -- and it is not always possible to charge pro-rated portions of labor cost to each such process and thus assign to the latter a cost value. In several cases we shall have to be content with associating a behavioral element whose value is known with a large group of material elements whose value is to be inferred from that of the behavioral elements. In the end we will have a limited number of process complexes, most of which include one or more productive tasks and the physical, material processes which are most directly consequent upon that, rather than some other, group of tasks. Each group will have some sort of value attached to it, based either on labor, on purchased or purchasable materials, or on both, with the value-coefficient, though inaccurate, providing a rough measure of the intensity of the given process complex in relation to that of other complexes. Each such complex can be considered the elementary functional unit in the model we are developing.

[3] The relative costs of these tasks do not, of course, mirror their importance in production or crop ecology in all cases. Weeding, for example, is less important than its cost would indicate, while watering is more important.

(Were our data more precise, the units could have been smaller and more carefully delineated, limited, preferably, to one task and its immediate effects, or one ecological transaction in each case.)

(1) Fertilization and its effects. The tasks involved in this complex include applying dry fertilizer and preparing and applying wet fertilizer. The most important effects are two-fold: maintaining soil nutrient supply at a level constantly high enough to release sufficient plant nutrients for optimum growth in relation to N, P, K, and Ca supply, i.e., to prevent nutrient supply from becoming a limiting factor in crop growth rate; and maintaining stable soil structure through processes involved in the decay of the organic fertilizers. The value of this complex is high, in fact higher than all others put together. It is made up of: labor value of $120, purchased materials value of $2,980; and minor costs for tools and hypothetical rental for storage space in the farm house. Total value is over $3,130 per year.

(2) Tillage and its effects. The tasks involved in this complex include: rebuilding a bed after harvest, including shaping it and returning eroded soil to it; and mechanically (with the hoe or rake) breaking down soil aggregates into smaller pieces. The important effects include: change in the form of the bed; loosening up of the soil in the root zone; improving soil aeration; increasing root room; diminishing runoff in proportion to intake of water. The value of these processes totals $500, the labor cost, plus a small cost for

replacement and repair of hoes and other field implements.

(3) Watering and its effects. Watering includes two tasks, one being the use of the dual-bucket apparatus, the other use of the small hand-pump and pail. The important effects include: maintaining soil moisture at or near the optimum for plant growth, especially during periods of sunlight when growth is most rapid if water is not a limiting factor; maintaining high humidity and lowered temperature between the plant canopy and the soil, to diminish evaporation; wetting plant leaves apparently to lower temperature and diminish transpiration and consequent water loss; supplying moisture to increase the rate of decay of fertilizers. The value of this complex includes a $210 labor cost and small additional depreciation on equipment.

(4) Planting and transplanting and their effects. Sowing seed, removing seedlings, transporting them to a maturing bed, and replanting them there, are the tasks involved in this complex. The effects are rather indirect, consisting as they do of changes in soil character consequent upon the new roots growing in the beds, and the thickening leaf-canopy overhead. The value includes $80 for seeds (purchased or farm-produced), $250 for labor, and $20 for supplementary labor involved in collecting the seeds, giving a total value of about $350.

(5) Weeding and its effects. This unprepossessing task, carried on at irregular, short intervals, and frequently by children, but nevertheless consuming much productive time, has the important effect of reducing competition given the

vegetables by weeds for soil nutrients, water, and sunlight. It has the further effect of providing an organic additive to burnt earth. The _value_ of weeding, derived entirely from labor costs, is about $270.

(6) _Spraying pesticide and its effects_. This minor task is self-evident in its _effects_, although we should point out that the effects are largely above the soil surface. _Value_, totalling about $170, comprises the cost of the pesticides, e.g., DDT and _Derris elliptica_, amounting to about $120 per year, the labor cost in applying it, about $50, and minor charges for maintenance of the hand pump.

(7) _The preparation, application and effects of burnt earth_. Burnt earth, consisting of baked, or at least oxidized, reddened clay and baked weeds, vegetable waste, and _lalang_, is prepared by means of a set of tasks which consist of supplying the pile with new organic and mineral additives and keeping it smouldering. It is applied in much the same manner as is fertilizer. Its _effects_ are rather complex, though perhaps not of critical importance. These include: adding to the soil a substance consisting of small particles which neither wet easily nor become firmly imbedded in the moist clay of the beds, thus loosening the surface soil (perhaps also accomplishing this by extracting water from the clay mass) and making it easier to till, more adequately aerated, and more capable of absorbing rainwater; also, adding a fertility increment in the burned organic matter included in it. The _value_ of burnt earth, entirely derived from labor expended in preparing and

applying it, is only about $10.

In a schematic model of this sort it will be sufficient for us simply to refer in passing to two minor crop-ecological process complexes, neither of which is high in value: (8) deepening ponds and drains and (9) cutting lalang. Together they have a value (in labor) of about $10 per year.

A number of important complexes may be looked upon for the most part as peripheral to leaf-stem vegetable production, for two reasons. First of all, they usually involve transactions across the field's boundaries, and second, they either precede, or follow, the crop cycle, or occur as minor strains throughout a number of cycles. One is highly significant: (10) the sequence of tasks from harvesting to marketing. This complex is higher in labor value than all others, its labor value totalling $770. The direct effect is primarily on orientation and behavior rather than materials. Supply (11), though involving high-value transactions, is not in itself a high-value process complex. Tending stock (12) is peripheral for our model, since stock enterprises are not very important in the plain. However, these processes involve rather high value levels: The dependence on purchased stock feed characteristic of Kallang farms, usually too small to grow the bulk of their fodder needs without sacrificing part or all of the vegetable enterprise, results in a cash value of $360 for stock feed; in addition, labor input is sufficient to provide a labor value of $80 for preparing stock feed and feeding the animals; although more labor and cash are expended on other phases of the stock enterprise, in the absence of data we must assume the total value to be the sum of those enumerated, $440.

And finally, we must seek to deal with residues of two sorts, one a set of process transactions which seemingly cannot be assigned direct coefficients of value, since they are, it would appear, "free," and the other a set of general costs which we find it difficult to assign to one or several particular process complexes.

The first residual group includes a number of highly important ecological process-transactions which do not directly involve either productive behavior or purchasable materials, and thus cannot, apparently, be assigned value coefficients. Among these are (13) the effect of rain; (14) the effect of fluctuations in the water table within the subsoil and the effect of regional flooding; (15) the effect of insolation on photosynthesis, and (16) the effect of air, on crop growth. These, it will be noted, are externally impinging processes leading to transactions across the field boundary. But this does not excuse us from attempting to place them within the same quantitative functional model with all other process activities and transactions which occur within the field and across its boundaries. Although they are "free," they are still of great functional significance, which we should prefer to be able to measure.

The second residual group includes a number of fixed costs which seem impossible of being assigned to individual process complexes. Among these are: land rental (which averages about $50 per year); the value of that portion of the farm house which is involved in productive uses, and the hypothetical rent (an unknown, but probably small, portion of the $60 annual rental value of the house) for these uses; and perhaps also the cost which economists normally include as an interest charge on farm capital, which would probably not reach $200 for the average farm. (See Chapter XIX.)

One may consider the idea of taking this latter group of fixed costs, whose annual value may run somewhere between $150 and $300, and assigning the value to those ecological processes involving "free" acquisition of moisture, sunlight, and air. These fixed costs can be thought of as a real or hypothetical payment for the right to use a given piece of the Lower Kallang Plain and the moisture, sunlight, and air which come with it. (They are, in the largest sense of the word, rented.) One wonders, however, whether the ecological value of these resources can be limited to the $150-300 value of fixed costs. Still, no other means of valuing these resources is at hand, and our goal is to express in quantitative terms the entire functional complex of the Lower Kallang Plain farm, so we shall assume that moisture, sunlight, and air have an annual value of $150-300. Process complexes (13) through (16) involve these resources, and thus we have climate at least tentatively included in our model.[4]

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[4]In introducing a charge on farm capital and partial rental on the farm house as production costs, solely for the purposes of this model, we are putting farm expenses slightly out of balance with farm receipts.

To summarize, then, we have erected what is termed in this paper a functional model for the idealized Kallang leaf-stem vegetable farming field. Failings in data prevent us from filling in the models with an elaboration of quantitative and qualitative detail: It has proven necessary to group processes into a limited number of unit-complexes (material, behavioral, and, implicitly, orientational) in order to develop a model with numerical -- i.e., intensity -- coefficients for each processual unit, and with a degree of generality allowing all productive processes a niche (no matter how insecure) in the model. The next step, had we adequate data, would be to define in greater detail the individual process elements, and then proceed to examine not simply their direct effects on selected segments of the field, but their effects on each other and on the field as a whole. Such a model would permit accurate prediction, achieved by manipulating the quantitative intensity of each process element and examining the resulting effect on the field.

CHAPTER XXI

CONCLUSIONS

It may be argued, and with considerable justification, that many of the theoretical ideas, concepts and propositions alike, which were presented in Part II of this paper do not reappear later in substantive application: in other words, that much of the theory was neither applied nor tested in the field. This would necessarily hold true for those portions of the theory which evolved after the field period, in many cases as a result of reflection on the field data themselves. The idea of constructing a functional model, for example, emerged at the very end of the field period, and the lack of adequate data for the models described in Chapter XX may be attributed to this order of events.

In other instances, however, the blame for lack of application must be placed on the field situation: Processual research seems to require highly intensive data-collection, much of it dealing with topics -- such as resource apperception, values, costs and returns -- which require a high level of rapport between the investigator and the farmer, a level not always attained in this study. But the fact that processual research has such high threshold requirements for intensity may reflect on the theory itself: Is processual research worth the effort expended?

We submit that it is. And in all probability those who, with the writer, accept the twin propositions that the causal, explanatory study of man's use of his material environment is a worthwhile endeavor, and that our failure to handle the subject properly so far is a result of the casual, superficial, and often sloppy field work characteristic of the environmentalistic ecological geographers, will agree that intensity, combined with an orientation stressing processual, dynamic, problems rather than static, spatial ones, is the order of the day.

Although certain phases of the theoretical approach did not receive a field test during the course of this study, others did. A conceptual system is neither provable nor disprovable: It is either useful or not. Thus field work "tests" such a theory by attempting to apply it, and determining, first, whether it is workable, and second, whether it helps in the solution of problems. It would seem desirable at this point to examine the degree to which the theory described here succeeded on both counts.

That the approach, or at least those portions of it which figured in the collection of data, proved itself workable can be judged from the preceding chapters. The use of the overall processual viewpoint presented no problem, so long as one remained aware of the kinds of data which were relevant to process analysis. In the use of particular concepts, success was variable. The field concept was easily applied, since our work was done on the level of the individual farm and the synthetic picture of the functional field was in many ways analogous to that of the "typical" Kallang farm. The division of material into three process categories -- orientation, behavior, and materials -- proved meaningful; however, the first category turned out to be quite elusive, although we tend to blame this on practical rather than conceptual difficulties. Only in the area of historical-process analysis were there any signs that the concepts might be difficult to use, but here our data were so meagre that no proper test of the concepts themselves can be said to have taken place.

In attempting to answer the question whether the theoretical approach helped in solving the essential problems of the research, we must return to the statement of substantive aims presented in Chapter I. These stressed the goal of understanding leaf-stem vegetable farming in Singapore as a dynamic, functioning system, in terms of both the short-run processes working within and on the farms and the long-run evolutionary processes which serve to explain present patterns in the large. Viewed from the standpoint of these goals, it becomes clear that some form of processual conceptual system, and a methodology to fit, are necessary. The concepts developed in Chapter III in large part represent an attempt -- rule-of-thumb during the work, and somewhat smoothed thereafter -- to build such a system of concepts: None other was available. Thus we can say that the conceptual system was not only useful, it was essential, as a direct consequence of the kind of problem we set ourselves.

Process analysis as a theoretical approach requires some methodological support to translate it into practise. The present study employed one set of methods found suitable to the particular problem being dealt with; other studies, of other systematic phases of cultural geography, and even other regions, will evidently have to employ others. It does seem, however, that certain imperative rules govern the methodology used in all functional studies of cultural-geographic process. Among them are the following:

(1) The level of intensity sought must be high. This is a logical consequence of the fact that our aim is to explain as well as describe: In description the investigator can set his own standards for intensity, but in explanation the problem itself sets the standards, since the need is for satisfactory evidence that a given set of processes, causal chains if you will, is, in fact, the real one.

(2) The breadth of data collected will usually be considerable, thus requiring excursions deep into other sciences. Even where a problem is narrow in scope -- as in the study of selected systematic elements -- one can be certain that it will draw the investigator far out of conventional geographic channels. This follows from the fact that all cultural effects are the product of a multitude of disparate causes. Therefore, most, if not all, process-oriented research will require the extensive use of methods and concepts employed in other sciences. Agricultural economics, agronomy, and soil science figured heavily in the present study; cultural anthropology was also brought in for certain phases of the work, and should have been stressed much more than it

was.

(3) If, as we have argued, the data to be collected in a given functional study involve high intensity and considerable breadth, it follows that available resources of field-work time will be taxed considerably unless rather narrow limits are placed on either areal or topical coverage. An essentially "regional" problem of the sort dealt with here has to restrict itself areally, but as the number of topics falls off, areal coverage can increase. (Thus we have high intensity on a topically restricted problem in Kniffen's Louisiana House Types.)

A scientific discipline stands on three legs of theory: concepts, woven into one or another fundamental conceptual system, by means of which data are ordered, made meaningful, and seen to be productive of generalizations; methods, which together provide an array of tools with which to obtain the needed data, and thus arrive at the desired generalizations; and, finally, the generalizations themselves, each building on those which precede and underlie it, and each carrying the science one step forward. The present study has attempted to strengthen the conceptual underpinnings of geography in a way which appears to hold promise of putting to better use our more efficient methodological tools, and of pointing out significant problems, in our search for generalizations concerning man's use of his material surroundings.

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APPENDIX

APPENDIX I

FIELD SCHEDULES

While a number of different questionnaires were used in various phases of the work, only four are reproduced below. The first is the basic questionnaire used in the intensive interview of each farm. The actual field schedule consisted of summaries of the questions, followed by ruled blank tables in which the relevant information was recorded. Since the schedule was between ten and thirteen pages long (depending on the type of farm, and therefore types of desired information), only the questions are reproduced here. It should be pointed out that the interviewers did not take the questionnaire into the field after they had familiarized themselves with it: The summary at the head of each blank table in the schedule proved sufficient.

The second, again a questionnaire rather than a field schedule, is a check-list of items to be covered in the mapping program for each farm, with instructions to mappers included.

The third, also a questionnaire rather than a field schedule, is a sample of the form used for return visits to selected farms. The first portion, asked at each visit, covers yields, prices, and similar data. The second is merely a sample of the sort of intensive questions asked, a different one at each visit. (The question chosen here, purely for illustrative purposes, concerns soils.)

The fourth questionnaire is only partly relevant to the present monograph, since it is the one used in the island-wide reconnaissance survey of Singapore farms, very few of the data from which figured in this work. Again, it is the reduction of a field schedule to a questionnaire.

With regard to the order of questions, it should be pointed out that the apparently illogical order, especially in the first, the one used in the basic intensive interview, is, in fact, a deliberately conceived mixing of "difficult" questions, such as those dealing with yields, and "easy" questions (e.g., "have you been a farmer all your life?"). In the actual interview, some of the difficult questions listed early in the questionnaire were asked much later.

I. Intensive Questionnaire

1. List all ground crops, tree crops, and livestock types present on the farm now.*
2. Where are all these items sold?
3. Has the farmer's entire lifetime been spent in this occupation?**
4. List all types of fertilizer used on the farm.
5. Are the same kinds of fertilizer used on all crops?
6. For each crop, how many beds (fields) are there, and what is the total area under the crop?*
7. For each crop, what is the length of the total crop cycle in days?
8. List all methods of marketing employed for ground crops, and list the crops marketed according to each method.
9. What is the frequency of fertilizer application to each crop?
10. What amount of fertilizer is applied to each crop at each application? To the largest bed? The smallest? The average bed?
11. What types of seed are purchased? For each, what is the frequency of purchase, the average amount purchased during the past year, and the average price?
12. What types of seed are grown on the farm? For each, what proportion of the total supply is grown rather than purchased?

13. Have harvests been fairly good during the past year? Fairly bad?**
14. What crops were harvested every day during the past year? What crops were harvested less frequently?
15. For each crop, list the minimum daily harvest for those days on which some yield was obtained during the past year.
16. For each crop, list the maximum daily harvest for those days on which some yield was obtained during the past year.
17. For each crop, list the average daily harvest for those days on which some yield was obtained during the past year. Note: where an annual figure is given, specify whether a Chinese, western, or terminal (from 365 days ago) year is meant.
18. For each crop, what was the total harvest during the past year?
19. Which crops had relatively uniform yields throughout the past year? Which crops had varying yields?**
20. What factors affected the yields of all crops during the year?
21. For each crop, what proportion of the total harvest is sold? Consumed? Fed?
22. For each kind of purchased fertilizer, what is the frequency of purchase?
23. For each such kind of fertilizer, what is the quantity usually purchased? How long ago was the last purchase? How much was purchased then? When will the next purchase take place?
24. For each kind of fertilizer, is the same amount applied to equivalent areas of all crops?
25. What were the prices of purchased fertilizers at the last purchase? What were the average prices for the year?
26. For each kind of fertilizer, is it obtained entirely by cash purchase, entirely on credit, or partly on each (state proportions)? Ask also for purchased seed.
27. List the names and addresses of suppliers of seed and fertilizers.
28. What are the repayment terms for fertilizers and seed purchased on credit?
29. List the first, second, and third ranking crops in terms of value for (1) last year, and (2) the last five years.

(Questions 30 through 48 relate to one specific vegetable bed.)

30. What crop is grown in the bed at present?
31. How many days until the coming harvest?
32. How many days ago planted or transplanted into the bed?
33. How many days before planting did the last harvest end?
34. What crop was last harvested in this bed?
35. Was the last crop germinated in a seedbed?
36. How long was it in the seedbed before transplanting?
37. Describe in detail the method of preparing the seedbed.
38. Describe the practices carried out during crop growth (tending, watering, fertilizing, etc.).

39. Describe the method of transplanting.
40. Describe the method of preparing this bed before planting the present crop, if transplanted (building the bed, cultivating, watering, fertilizing, etc.)
41. Number of loads (pair of bucketsfull) of water applied to the bed before planting?
42. How many loads were applied yesterday?
43. How many are applied on a rainless, sunny day?
44. Is the bed weeded between planting and harvesting? Irregularly or at selected intervals?
45. What was the total amount of each kind of fertilizer used on the last crop in this bed?
46. What amounts were applied at each stage in the crop cycle (stage 1: before transplanting or, if not applicable, early growth; stage 2: later growth; stage 3: nearly mature and mature)?
47. How many applications of each kind of fertilizer, and how much at each application, was applied to the last crop in this bed?
48. What weight or volume of seed was used for the present crop?

49. For each variety of livestock (total chickens, laying hens and roosters, total ducks, laying ducks, total geese, total turkeys, total pigs, sows and boars, fattening pigs, other kinds): (a) How many are on the farm now? (b) How many were sold last year? Last month? (c) How many were purchased last year? Died last year? Eaten last year? Eaten last month?***
50. For each kind of stock feed used, how much was used last year? Last month? What were the prices last year? Last month?
51. How many hen's and duck's eggs were (a) gathered and (b) sold last year? Last month? Last week? During an average week last year?
52. Describe the method used for marketing each variety of livestock and livestock product.
53. List the first, second, and third-ranking livestock type or product in terms of value for last year and for the last five years.
54. What are the farmer's future plans for livestock?
55. List the number of trees of each type on the farm.*
56. How much was produced, how much sold, and how much consumed of each tree-crop product last year?
57. Describe the method of marketing tree crop products.
58. List the three best income-earners among all types of enterprises last year and over the past five years.
59. How long has the farmer been working this farm?
60. Describe the farmer's previous farming experience before coming to this farm. For each farm he worked, where was it? How many years were spent on it? How long ago did he leave it? What were the major crop and stock types?
61. List all other occupations he has held, stating where and when each was held.

62. Where and how did he learn to farm?
63. To do market gardening? With the present crops?
64. What was (is) his father's occupation? If he was a farmer: Where did he farm (country, province or state, and nearest major town)? What were the major crops?
65. How many men, women, and children are living on the farm now?
66. How many men and women are living on the farm and were working full-time on the farm all last year?
67. How many men and women are living on the farm and were working full-time part of last year?
68. How many men and women living on the farm were working elsewhere all last year?
69. Employment elsewhere of farm-dwellers: For each man and women employed elsewhere during any part of last year, list the number of days, weeks, or months employed elsewhere, the wage per day, week, or month, and the occupation and place of employment.
70. Was hired labor used at all during the year?
71. If so, how many laborers were employed, and, for each: How many man-days were put in at each wage rate and what was the wage rate? Were meals provided? What was the total number of man-days?
72. What kinds of insecticides, germicides, fungicides, etc., does the farmer use? How much of each did he buy during the year? What was the average price?
73. What has been the average weight of crops marketed per day of sale last year? Last week?
74. What has been the average income from sale of crops per day of sale last year? Last week?
75. What has been the average daily income from sale of livestock products last year? Tree crop products?
76. What was the total money income last year, including cash income and debt repayment?
77. How much was spent last year on repairs and additions to the farm structures? (Itemize.)
78. On tools and equipment? (Itemize.)
79. On other improvements? (Itemize.)
80. How much does the farmer owe altogether at present?
81. Is he more or less in debt than he was a year ago? How much more or less?
82. How much does he owe each of his creditors?
83. Would the farmer mind our returning next week or later to ask how much he produced during the period?
84. Grade the farmer (A,B,C,D) on (a) cooperativeness, and (b) apparent knowledge about his farm.
85. List the farmer's full name.
86. Date.
87. Names of interviewer, recorder, mapper.
88. Farm number.

*Information to be supplied by the mapper, not asked in the interview.

**Unimportant questions, asked simply to break the interview.
***Questions on pigs were asked only if the farmer showed no hesitation about discussing this enterprise, since pig-rearing is illegal in the plain. In some cases the mapper merely took a count of sows, boars, and fattening pigs.

II. Mapping Instructions, Intensive Interview

1. Obtain the farmer's permission to have you map his farm.
2. If necessary, ask the farmer to walk around the farm with you to point out farm boundaries, structures, fields, paths and water sources. Do this at the start of the interview, immediately after its purposes have been explained to the farmer.
3. Pace the farm boundaries and sketch these on your board.*
4. Pace and sketch the area and shape of each field or bed.*
5. Pace and sketch all farm structures and ponds.
6. Count all fruit trees of each type, and sketch their positions.
7. Count all pigs (sows, boars, and fattening).
8. If the farm is on both sloping and flat land, sketch in the break of slope and estimate (by eye) the approximate difference in elevation between the high point and low point, indicating this on your map.
9. Indicate the bed or field selected for special questioning.
10. Sketch adjoining roads and paths, internal paths, lalang areas, and other mappable features.
11. Indicate the crop or crops grown on each bed or field, and the stage of growth.
12. Calculate the total farm area, total cultivated area, and area under each crop.
13. Trace the sketch and turn in the tracing with the schedule.

*Compasses were not available. Most angles, and nearly all bed angles, were right angles.

III. Questionnaire Used on Return Visits to Selected Farms.

(Question 2 was changed at each visit, the question shown below being one of about 10 asked on different occasions.)

1. Production record: for each type of produce, ground crop, tree crop, and livestock, list (a) the quantity sold, (b) quantity consumed, (c) quantity fed, and (d) the prices obtained for the period since the last visit.
2. Soils question: What does the farmer consider to be the "ideal" soil for the major crops grown on his farm, in terms of water retentiveness, ease of cultivation, fertilizer retentiveness, etc.? Are his soils "good" or "bad" for the crops grown? What special soil problems does he have (erosion; water; cultivation)? (The fundamental

purpose of this question is to obtain the farmer's opinion of the soils of his farm, whether they are good or bad, and how they compare with an "ideal" type of soil for the types of crops he grows. Be extremely exhaustive with this question; try to provide at least a page of information -- explore all aspects of the subject, encouraging the farmer to mention anything on it that occurs to him.) This question is to be asked on all selected farms.*

3. State the area (Lower Kallang Plain, Lokyang, etc.), the interviewer, the farm number, the number of this visit, and the number of days since the last visit.

*Some questions in this group were asked on a specified proportion of the selected farms, others on all.

IV. Reconnaissance Farm Survey Questionnaire

A. Observational Data

1. Farm number and zone number.
2. Interviewer's and mapper's names.
3. What enterprises are present on the farm (leaf-stem vegetable, fruit-earth vegetable, livestock, tree crops)?*
4. If both leaf-stem and fruit-earth vegetables present, indicate areal proportions.
5. If tree crops present, indicate areal proportion of tree to ground crops.
6. Indicate the relief of cultivated land in terms of one or more of the following classes: lowland flat; gently sloping; steeply sloping; upland flattish.
7. Indicate colour of cultivated soil in terms of one or more of the following classes: reddish; yellowish; light greyish or grey-brown; dark greyish or dark brown.
8. Indicate the texture of cultivated soil in terms of one or more of the following classes: clayey; sandy; intermediate.
9. What is the major leaf-stem vegetable crop, in terms of area?
10. What is the major fruit-earth vegetable crop, in terms of area?
11. Are tapioca and/or sweet potatoes the only fruit-earth vegetable crop?**
12. If an interview cannot be obtained: Does the farm have a pig sty? Approximately how many pigs are on the farm? Are there more than 25 chickens? Explain why an interview cannot be obtained (farmer not home, refused to be interviewed, etc.).

B. Interview Data

13. How many people are dwelling on the farm now -- i.e., slept here last night?

14. What is the total farm area, to the nearest acre, or, for small farms, half acre.
15. What is the farmer's dialect or, if non-Chinese, language?
16. How many pigs does he have?
17. How many chickens?
18. If other types of livestock are more important than pigs or chickens, list kind and number.
19. What is the most valuable product sold by this farm?
20. What is the major source of income, as among ground crops, tree crops, and stock?
21. Are the interview data reliable?

*Certain crops were classed as leaf-stem <u>or</u> fruit-earth vegetable, depending on land conditions.

**A "yes" answer to this question implies that ground crops are used only as stock feed.

VITA

James Morris Blaut was born in New York City on October 20th, 1927. He attended primary school in that city and high school in Providence, Rhode Island. His undergraduate college education, except for one year at the New School for Social Research and a summer at Columbia University, was obtained at the University of Chicago, between 1944 and 1949. He received the degree of Bachelor of Philosophy from that institution in 1948 and that of Bachelor of Science in 1950 (<u>in absentia</u>), majoring in geography and minoring in economics. During his years in high school and college he held various summer and part-time jobs on farms in Vermont and Rhode Island, with the U. S. Forest Service in South Dakota, with a railroad in Chicago, with market research firms in New York, and in a zoological laboratory and the biological library of the University of Chicago.

His graduate study included a year (1949-1950) at the Imperial College of Tropical Agriculture, Trinidad, British West Indies, where he majored in tropical soils, and two years in residence (1950-1951, 1953-1954) at Louisiana State University. At the latter institution he obtained the degree of Master of Science in 1954, majoring in geography and minoring in agricultural economics.

During the period 1950-1951 he held an appointment as

Graduate Assistant in Geography at Louisiana State University. Between 1951 and 1953 he was Assistant Lecturer (instructor) in Geography at the University of Malaya and voluntary Director of the Singapore Agricultural Survey. Between 1954 and 1956 he served in the U. S. Army, rising to the rank of Private First Class. During his military career he served for a brief period in the Army Map Service, then spent a year as Physical Geographer with the Environmental Protection Division, Quartermaster Corps, undertaking research on Middle American climates. A position as Instructor in Geography at Louisiana State University during the summer term of 1956 was followed by an appointment as Instructor (subsequently Assistant Professor) in Geography at Yale University.

In addition to the work described in this dissertation and the study undertaken while in military service, he has carried out research in Jamaica and Costa Rica. He has travelled through much of Southern Asia and Middle America.

EXAMINATION AND THESIS REPORT

Candidate: James M. Blaut

Major Field: Geography

Title of Thesis: Chinese Market Gardening in Singapore: A Study in Functional Microgeography

Approved:

Fred B. Kniffen.
Major Professor and Chairman

Richard J. Russell
Dean of the Graduate School

EXAMINING COMMITTEE:

John H. Vann Jr.

William G. Haag

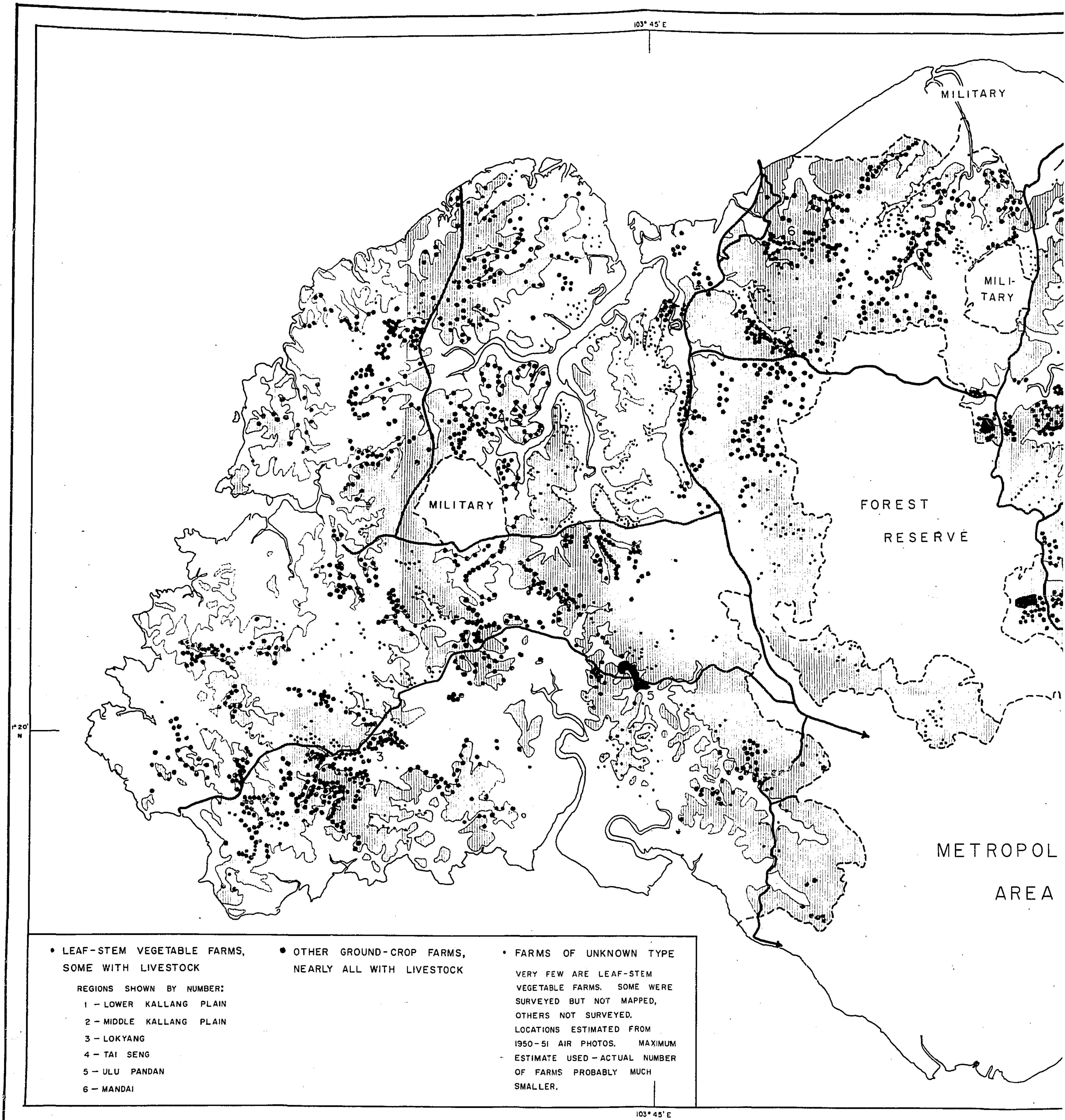
Martin Wright

M. B. Sturgis

Wm. G. McIntire

Date of Examination:

July 3, 1958



• LEAF-STEM VEGETABLE FARMS, SOME WITH LIVESTOCK

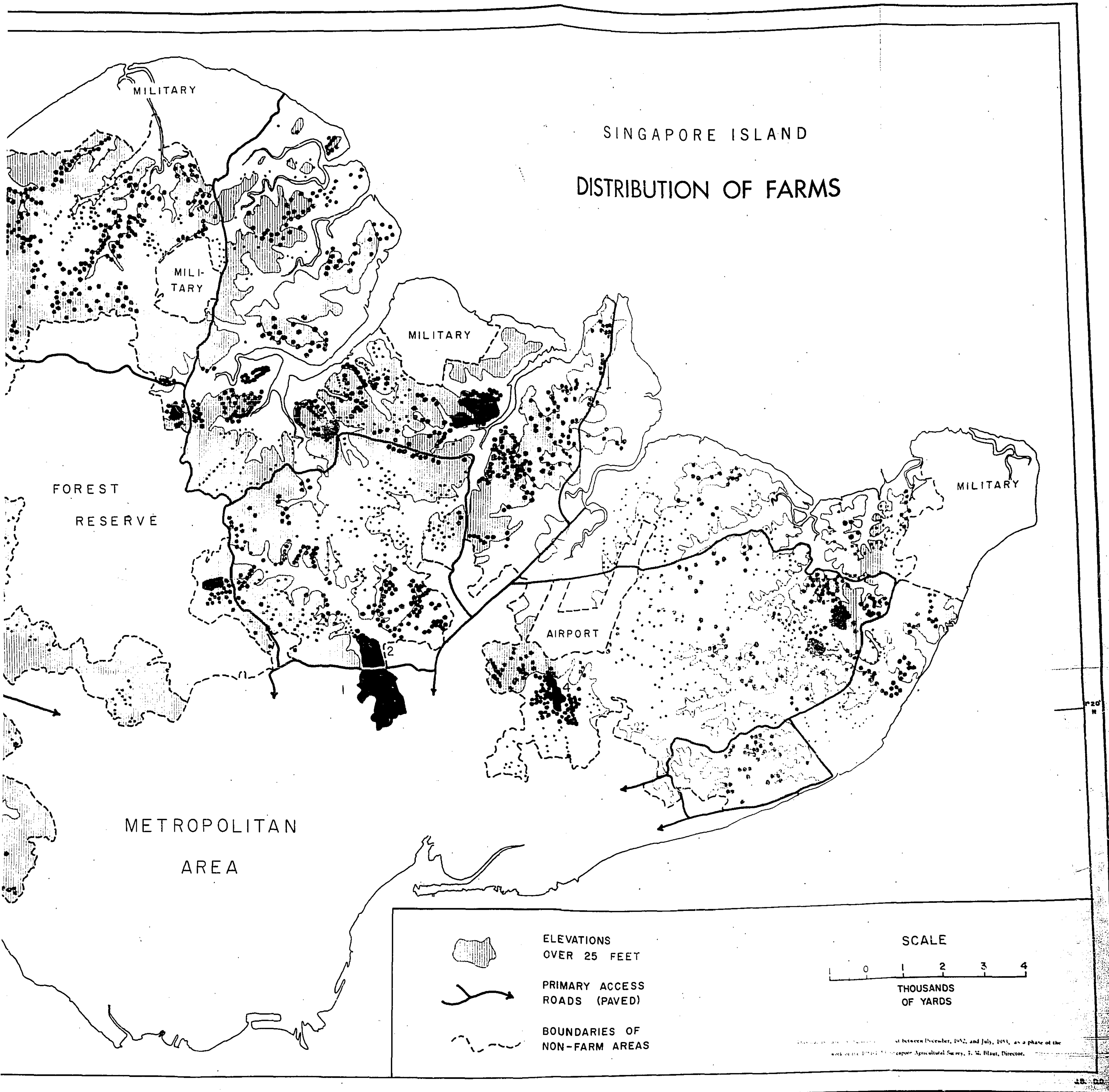
REGIONS SHOWN BY NUMBER:

1 – LOWER KALLANG PLAIN
2 – MIDDLE KALLANG PLAIN
3 – LOKYANG
4 – TAI SENG
5 – ULU PANDAN
6 – MANDAI

● OTHER GROUND-CROP FARMS, NEARLY ALL WITH LIVESTOCK

· FARMS OF UNKNOWN TYPE

VERY FEW ARE LEAF-STEM VEGETABLE FARMS. SOME WERE SURVEYED BUT NOT MAPPED, OTHERS NOT SURVEYED. LOCATIONS ESTIMATED FROM 1950-51 AIR PHOTOS. MAXIMUM ESTIMATE USED – ACTUAL NUMBER OF FARMS PROBABLY MUCH SMALLER.


SINGAPORE ISLAND
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